A CAHNERS PUBLICATION INTERNATIONAL EDITION OCTOBER 29, 1987

EDN®

Techniques tame noise in high-speed CMOS designs

VME Bus system replaces a 68000 with an 80386

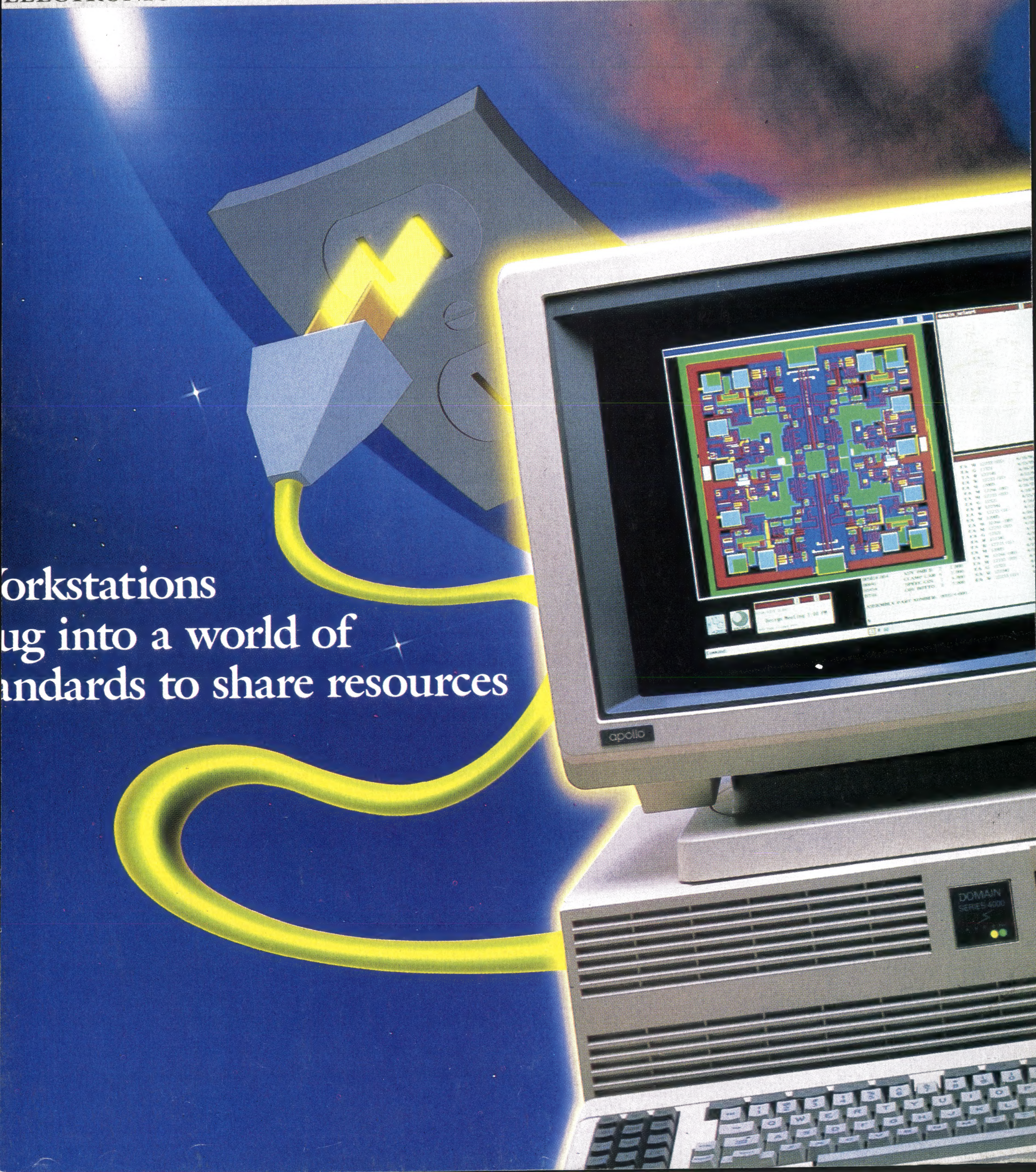
Voice-synthesis digital ICs

Wescon/87 preview

Salon des Composants

6 NOV 1987

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS



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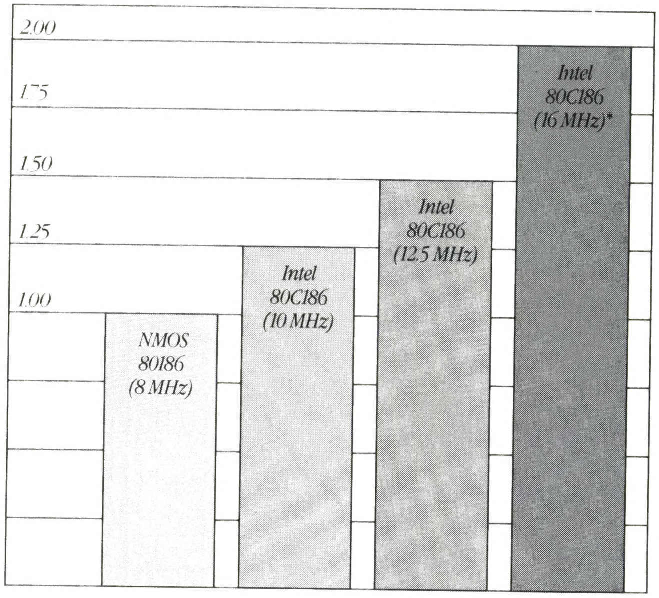

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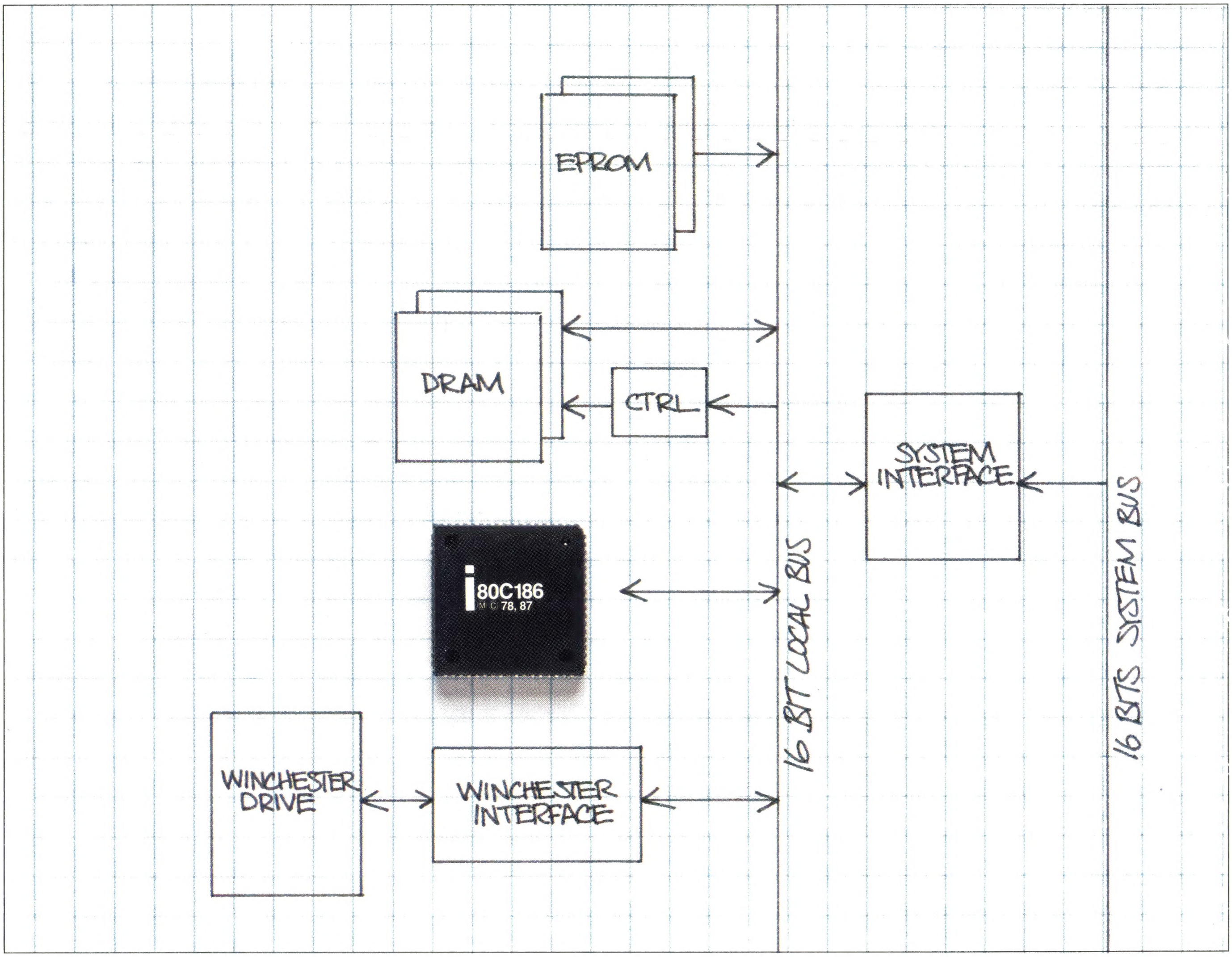

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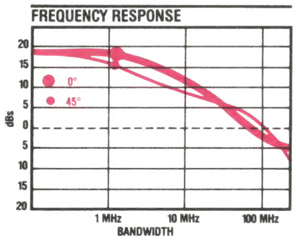

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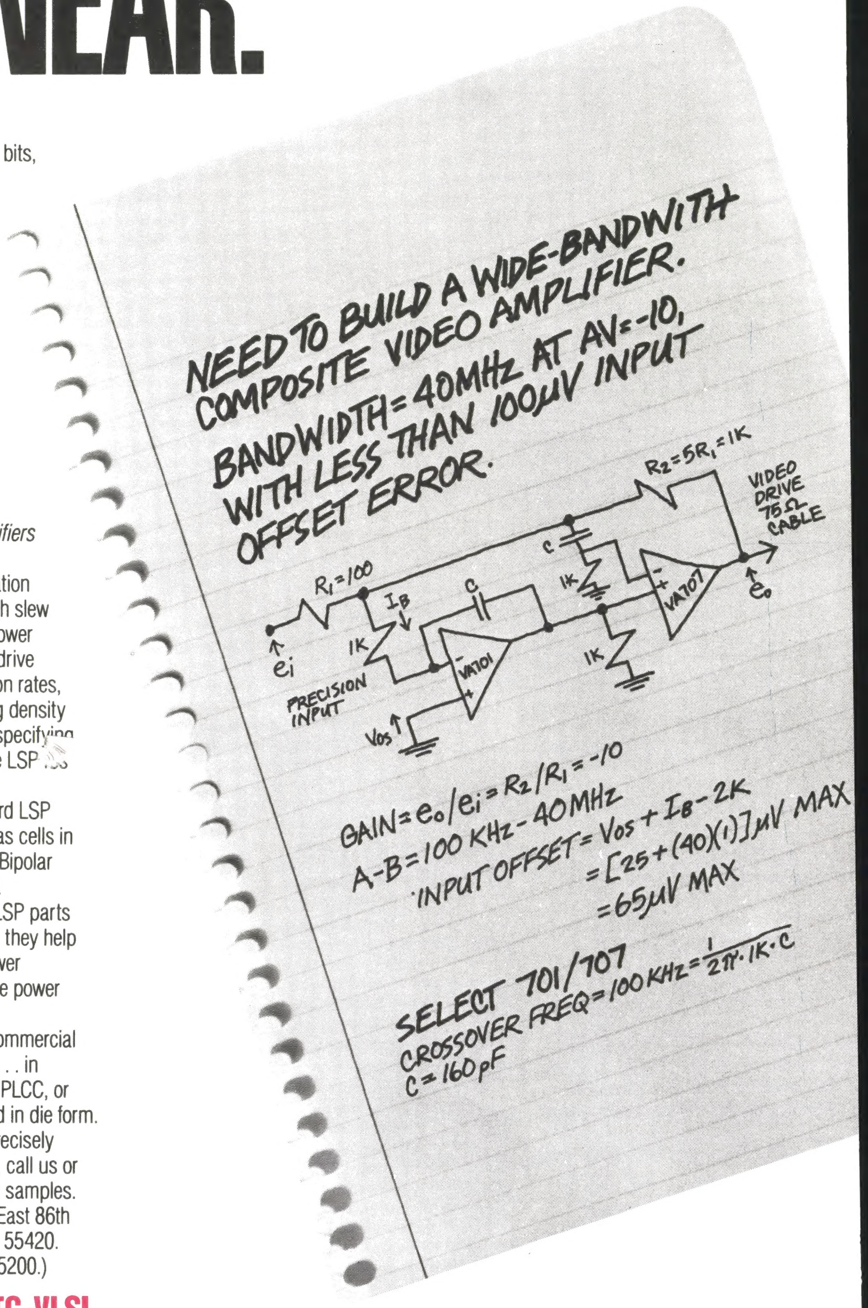

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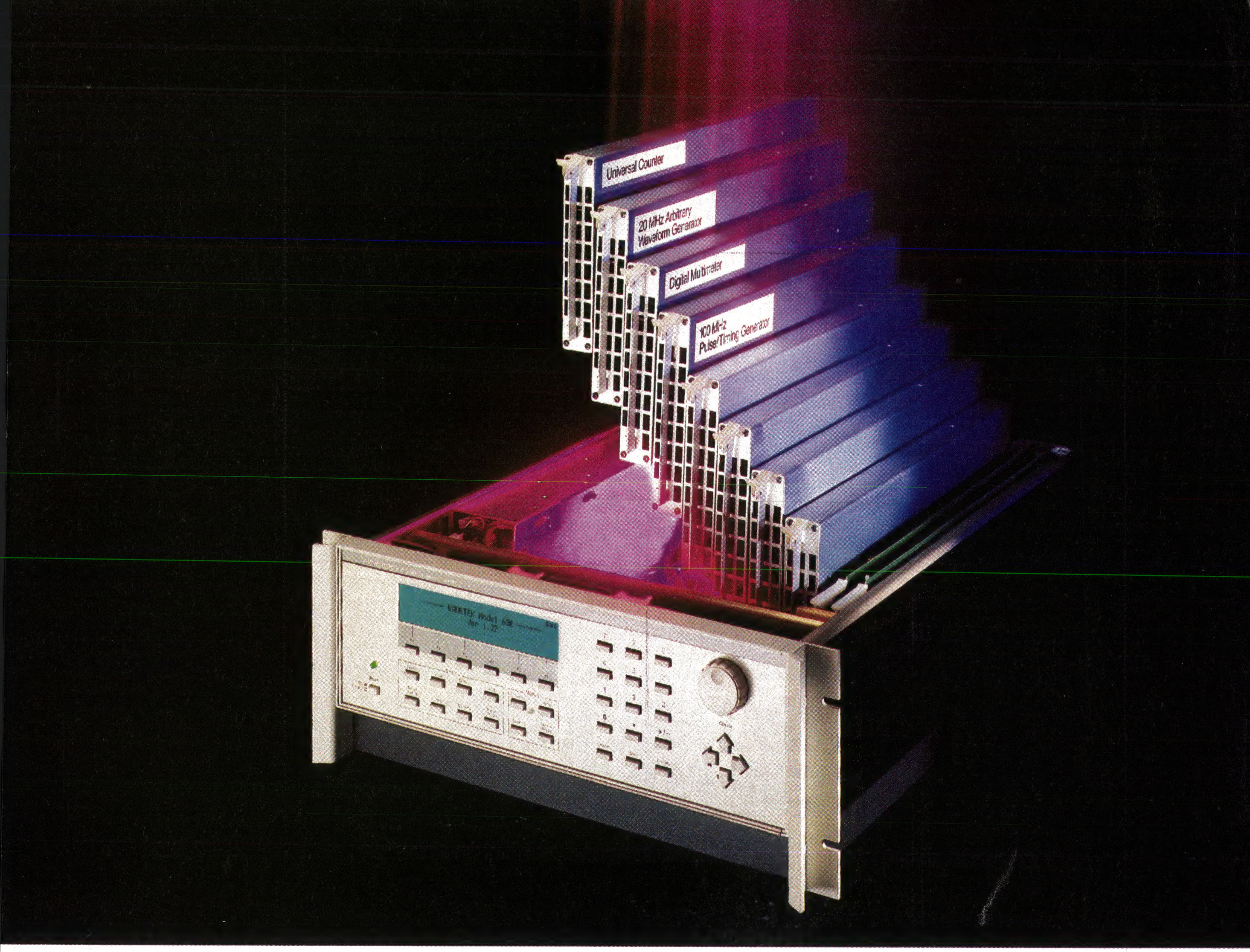
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   o  System primitives permit implementation of semap
      gateways
   o  Scheduling and intertask coordination primitives
   o  Full preemptive, time sharing and real-time kern

 DOS
   o  Executes all DOS system calls without fear of re

PARALLEL.ASM
 Inpt Bit
 76543210
            Port 0
            Port 1
            Port 2
            Port 3
            Port 4
            Port 5
            Port 6
            Port 7

SERIAL.ASM
 INOFW

KEYSTROK.ASM
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  Type any key to return to DOS

TYPFILE2.ASM
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   o  Ordered gateway to DOS enforces
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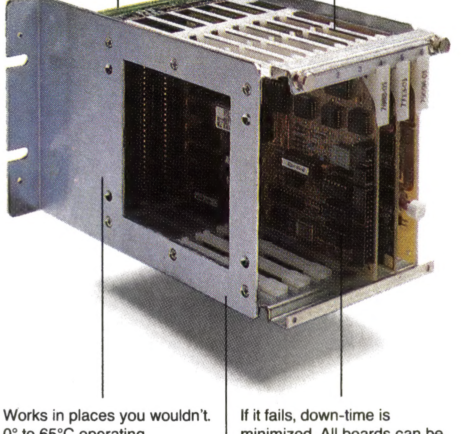

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INDUSTRIAL COMPUTERS PRO-LOG IN CONTROL QUALITY

Volume 32, Number 22

EDN

October 29, 1987

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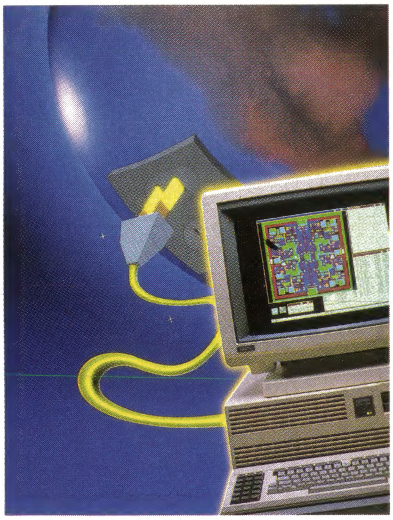

On the cover: *Because of the acceptance of three popular standards, your workstation can now hook up with the vast resources of other workstations on a network. See pg 168. (Photo courtesy Apollo Computer Inc)*

DESIGN FEATURES

Special Report: Workstations 168

KEEPING AMERICA COMPETITIVE

Workstation manufacturers have been very active lately: They have introduced many ''super'' workstations and restructured the prices of many of the older systems. Affordable workstations have also become powerful enough to exploit popular standards, particularly X Windows, Unix, and Ethernet.—*David Shear, Regional Editor*

VME Bus applications can benefit from 80386-based designs 189

Traditionally, designing for the VME Bus automatically meant a design based on a 68000 μP. But without too much trouble you can use an 80386 as a VME Bus CPU.—*Steph Rutel and X Kim Rubin, Force Computers*

FET op amps convert photodiode outputs to usable signals 205

Because FET op amps have low input currents, circuit designers almost universally employ them to monitor the outputs of most photodetectors. Your choice of an amplifier and circuit connection for use with a photodetector depends on the linearity, offset, noise, and bandwidth specs your application requires.—*Jerald Graeme, Burr-Brown Corp*

Good design methods quiet high-speed CMOS noise problems 229

No doubt about it: Today's high-speed CMOS logic can generate a significant amount of noise. This problem is not insurmountable, however. Circuit design techniques that are prudent but not unusual will readily tame troublesome noise.—*Tim Tripp and Bill Hall, Fairchild Semiconductor Corp*

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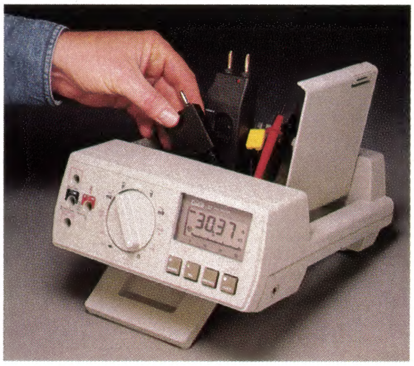

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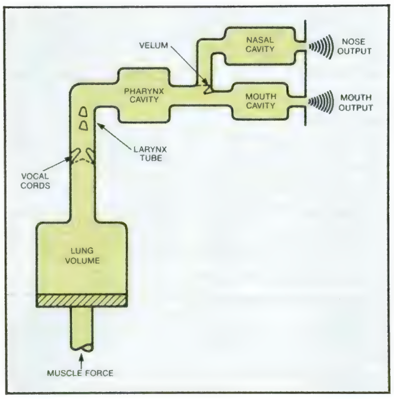

***The key to one voice-synthesis method**—parametric synthesis—is a model of the human speech production mechanism (pg 63).*

TECHNOLOGY UPDATE

Low-cost digital ICs provide flexibility for applications requiring voice output 63

Myriad applications are driving the development of low-cost digital ICs for artificial-voice synthesis, and these ICs are offering designers considerable flexibility.—*John Gallant, Associate Editor*

Refinements in CRT design boost resolution of color video monitors 81

It's easy to forget that as recently as a few years ago, color video monitors couldn't produce the detailed images needed for even moderately complex CAE applications.—*Chris Terry, Associate Editor*

Wescon/87 will highlight electronics in the entertainment and broadcasting sectors 97

Wescon/87 will take place from November 17 through 19 at three locations in San Francisco, CA.—*Charles H Small, Associate Editor*

Salon des Composants sessions will emphasize developments in passive components 109

Components for telecommunications and industrial automation will figure prominently in the Salon International des Composants Electroniques exhibition.—*Peter Harold, European Editor*

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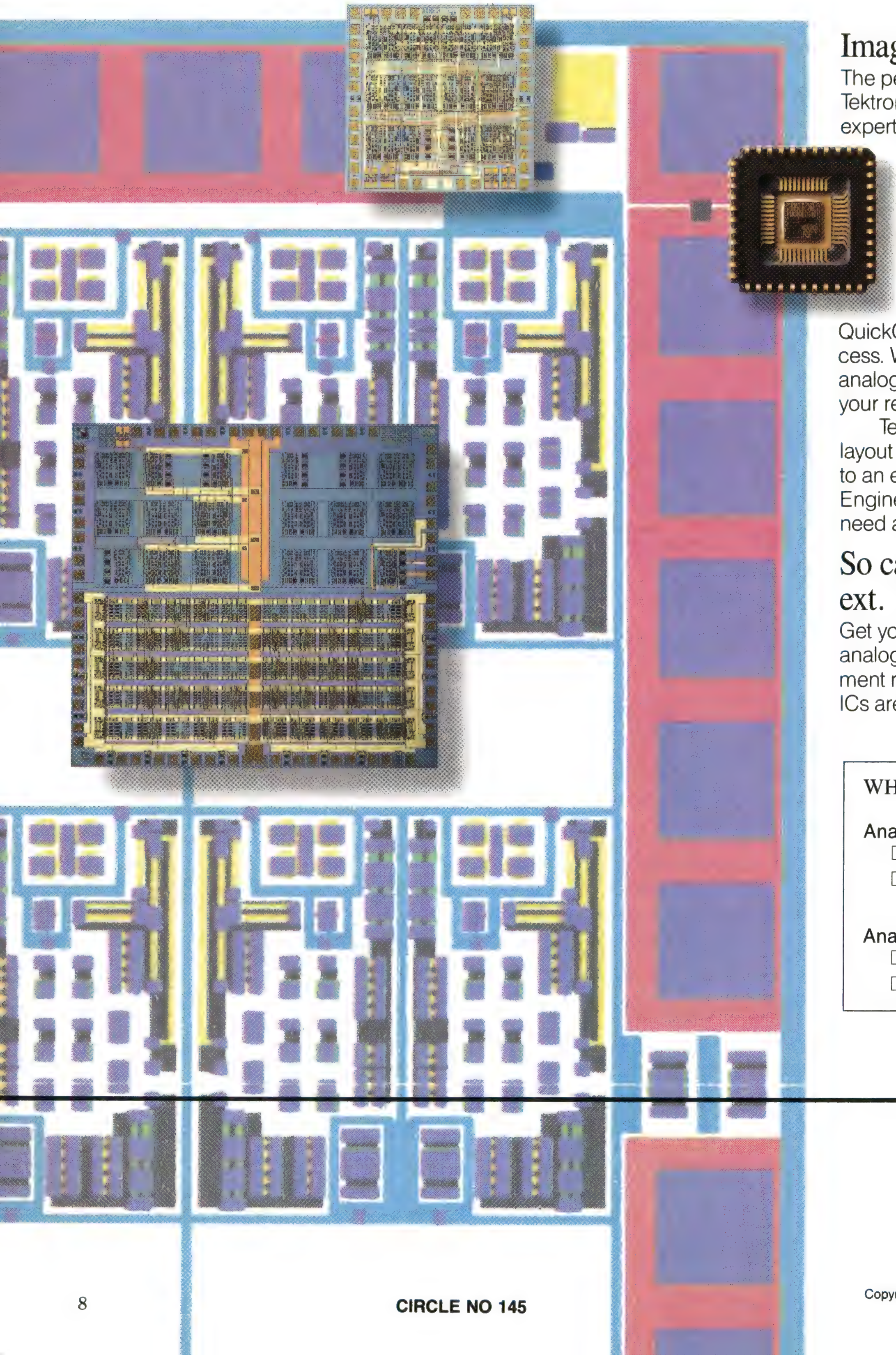

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Instead of banning digital audio tape (DAT) recorders, Congress should let the market forces determine the systems' future.

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Short boom in store for packet-switching industry. . .“Interoperability” is watchword in data sharing.

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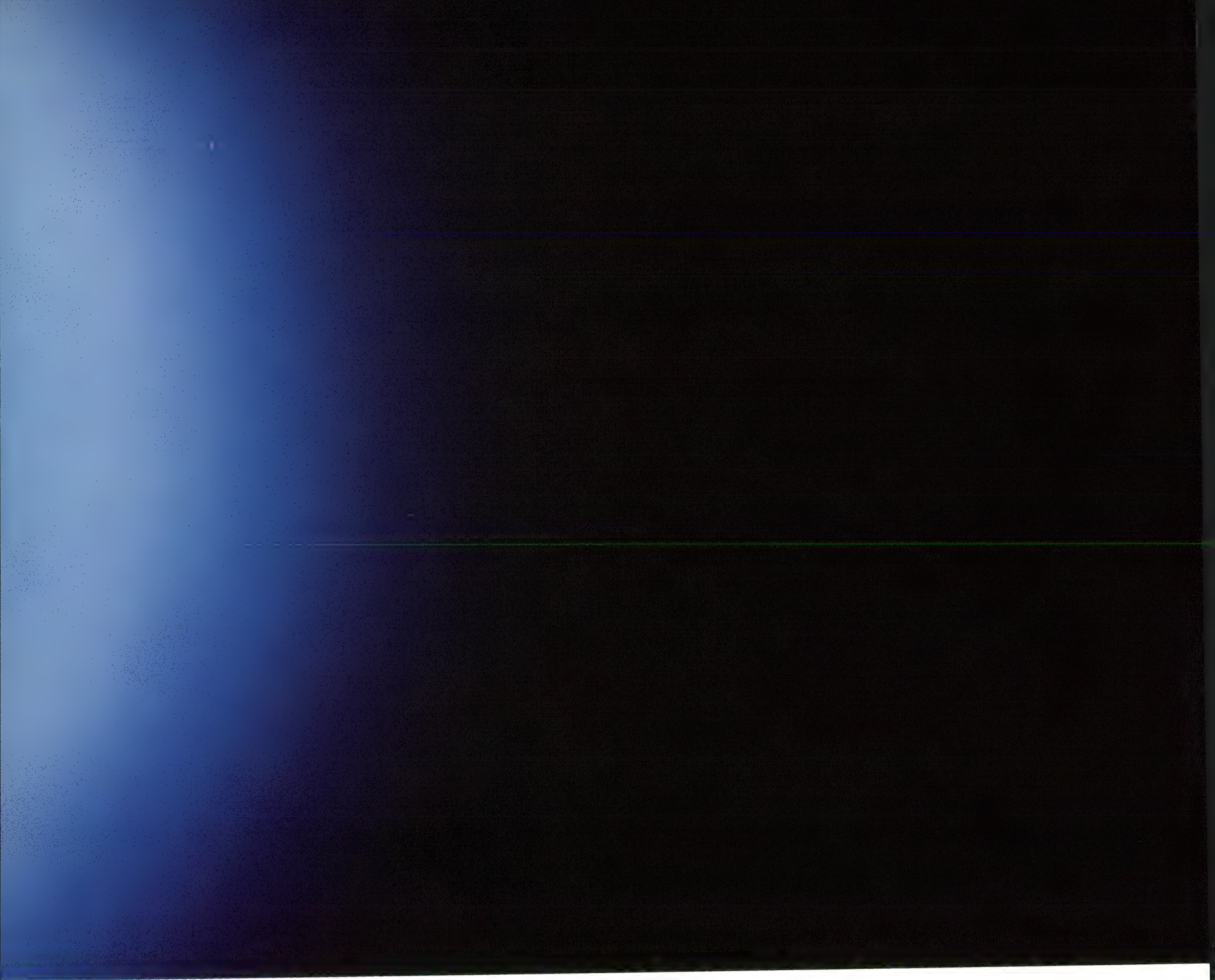

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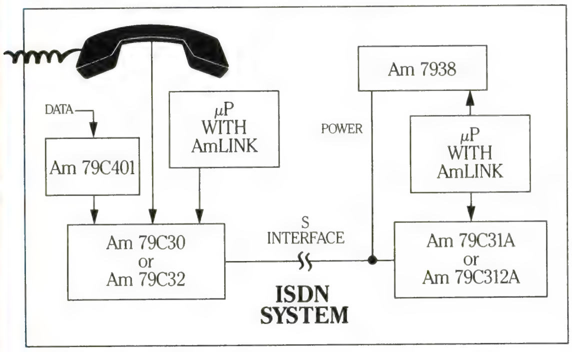

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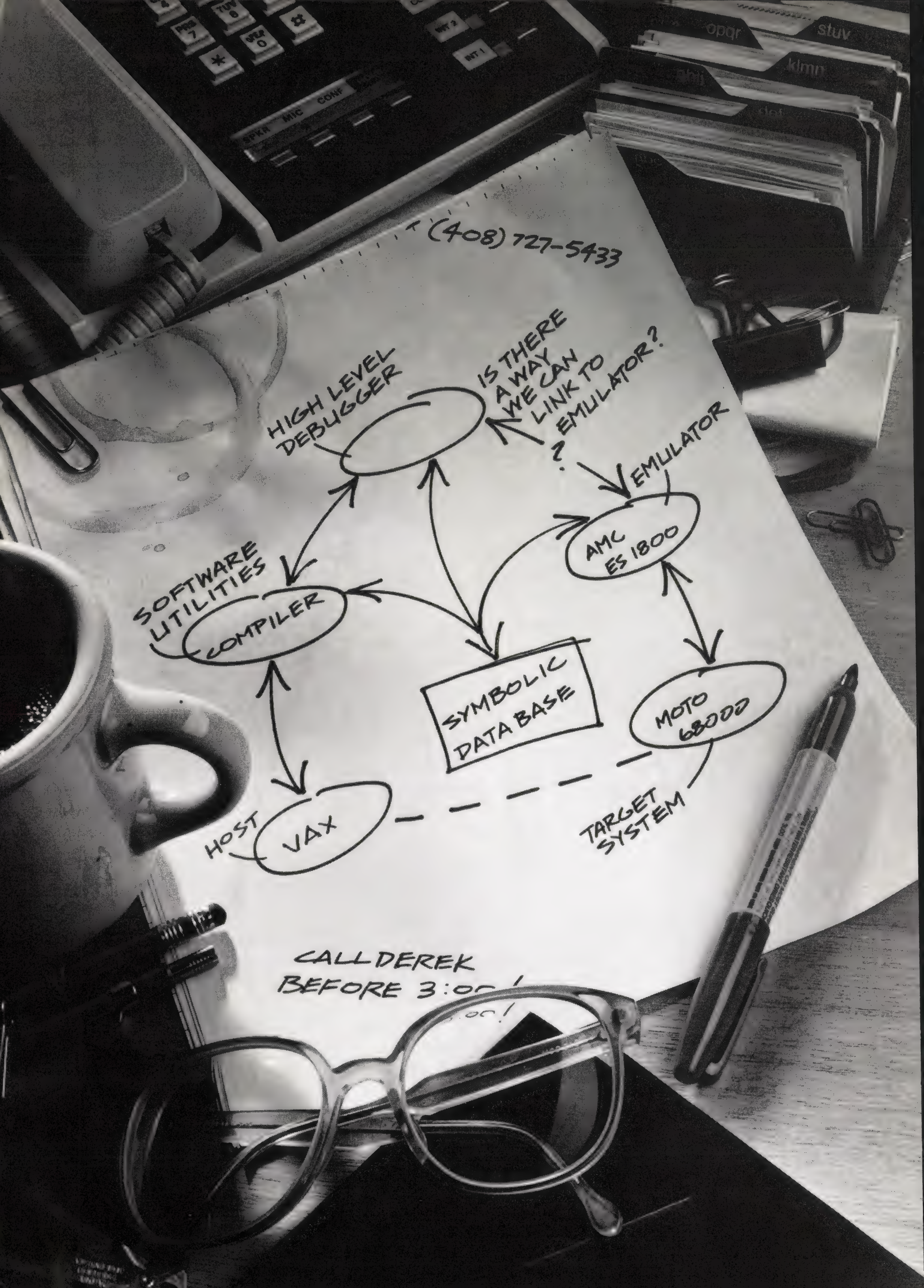
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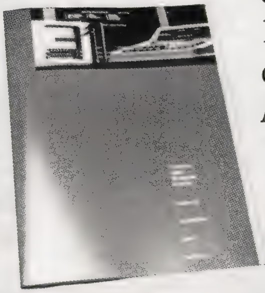

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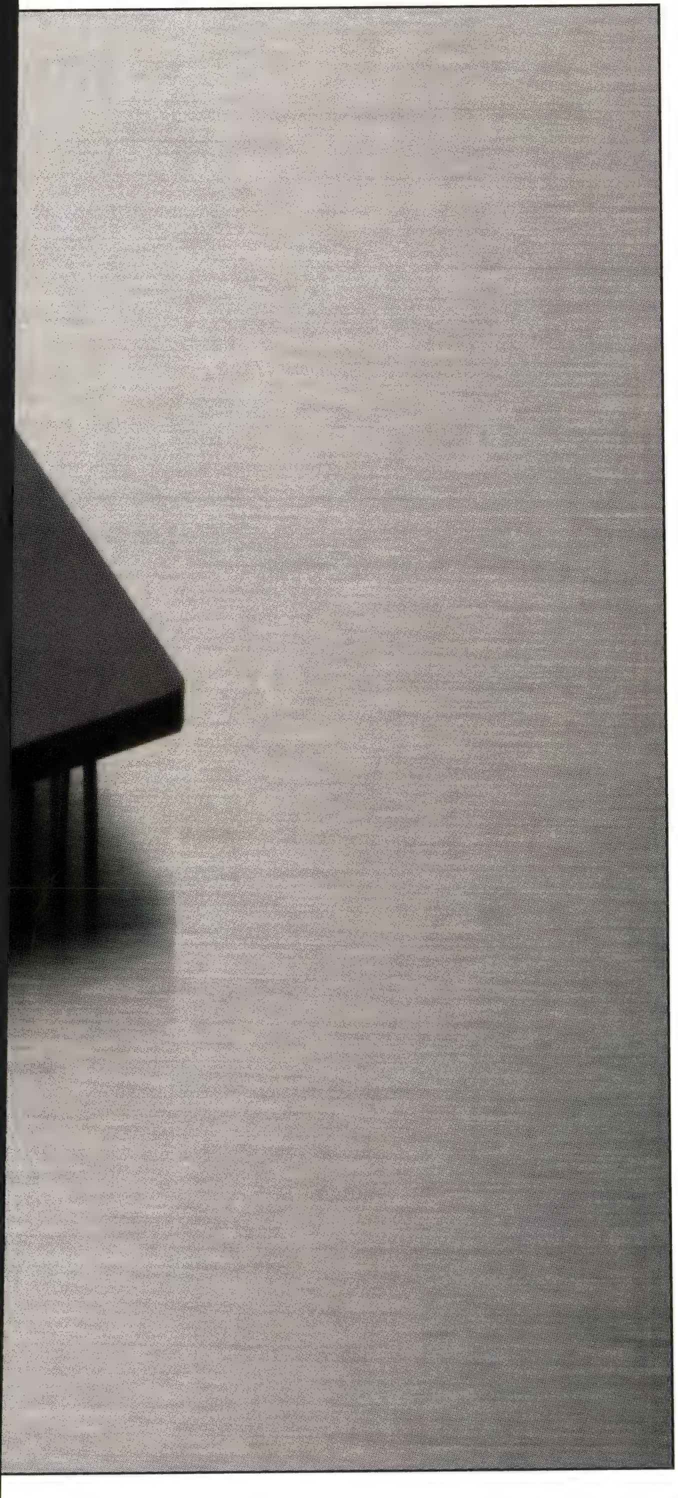

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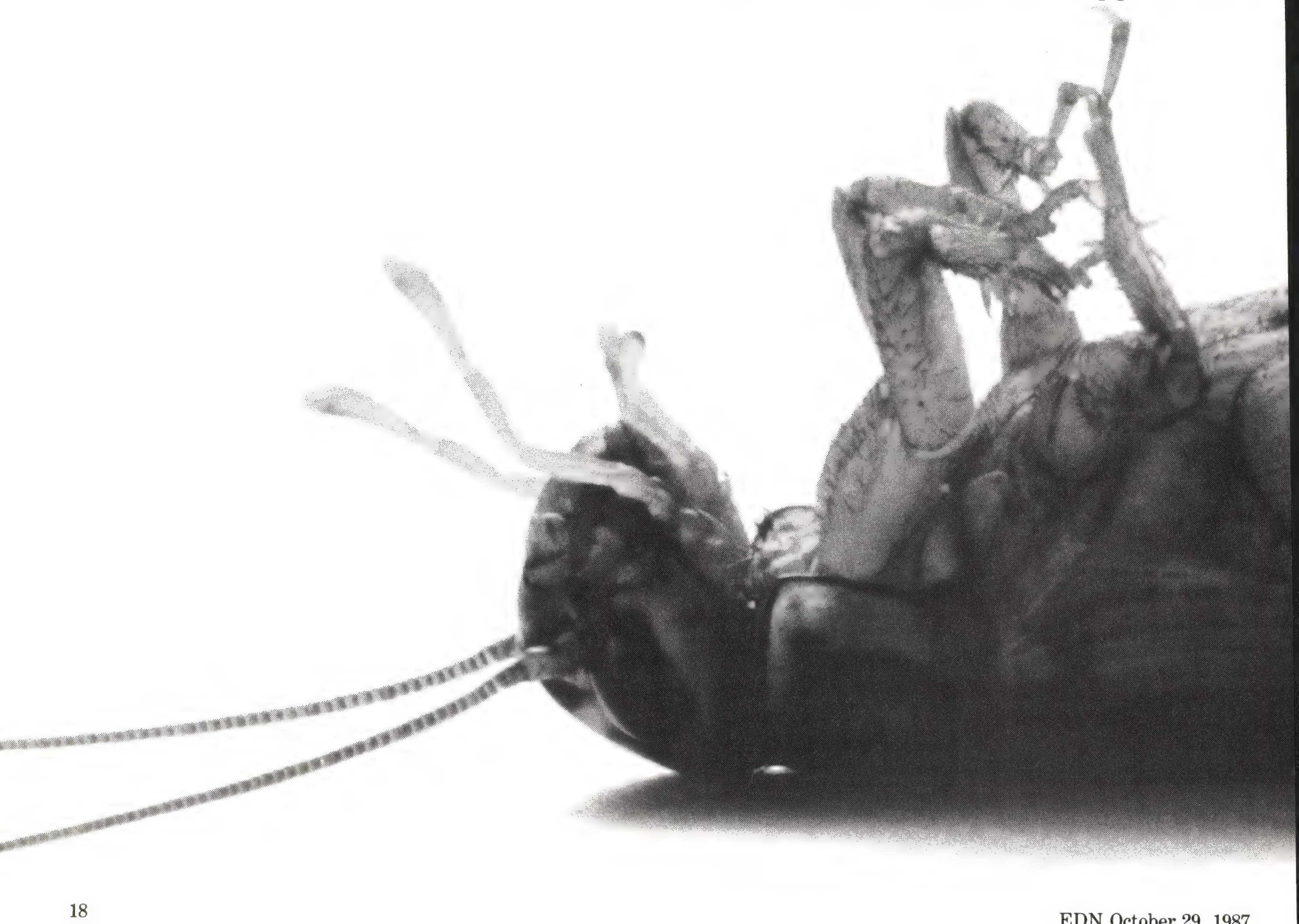

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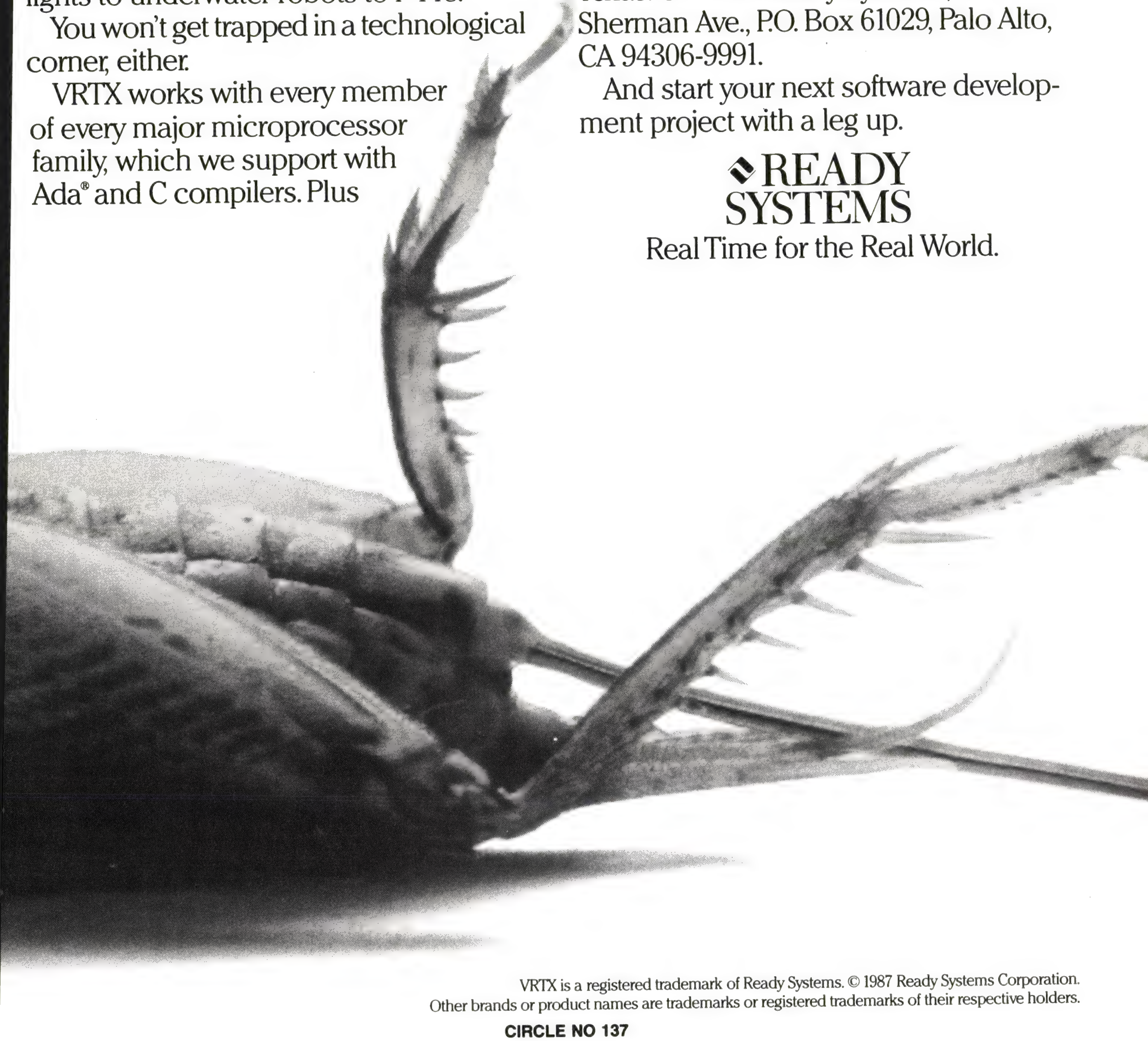

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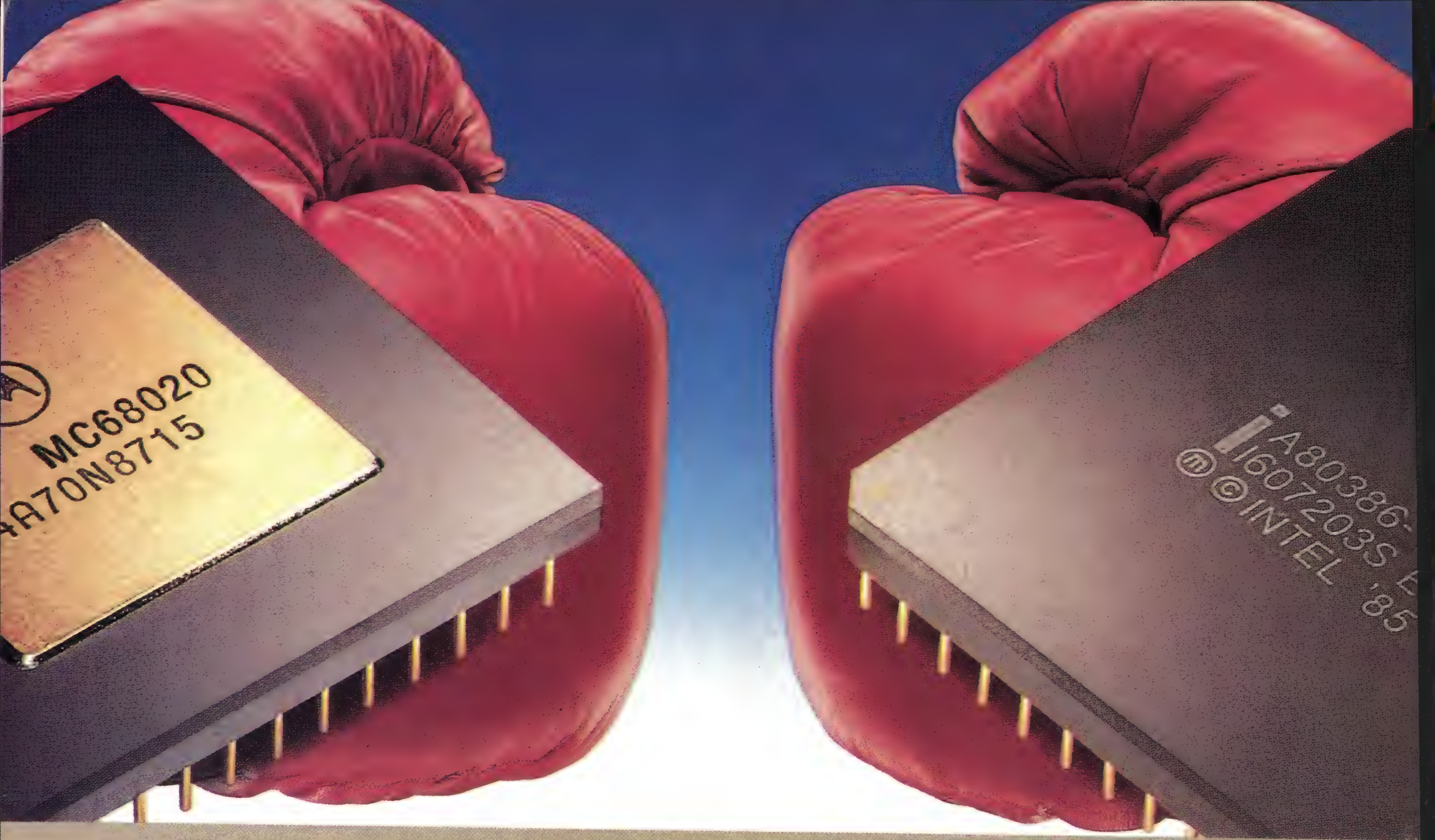

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*Processors supported by Microtek: 80386, 68020, 80286, 80186, 80188, 8086, 8088, 68010, 68008, 68000, 8031/32, 8051, 8344, 8751, 8048/49/50. 8748/49, Z8, ZS8, 80515, 68HC11, 64180, Z80, 8085, 6809E, 6502F, NSC800

NEWS BREAKS

EDITED BY JOAN MORROW

HIGH-SPEED CMOS 8-BIT μC INCLUDES AN ON-CHIP A/D CONVERTER

Motorola (Austin, TX) has upgraded the MC68HC05C4 with the introduction of the MC68HC05B6 μC, which adds an 8-channel A/D converter, two pulse-length-modulation (PLM) systems, 1792 additional bytes of ROM, and eight more bidirectional I/O lines. It also features a serial communications interface (SCI) with separate baud-rate selection for transmitter and receiver, a software-selectable Slow Mode, and a software-programmable external interrupt. This new μC costs $4.90 (OEM qty) and comes with 176 bytes of RAM, 5952 bytes of ROM, and 256 bytes of byte-erasable EEPROM. If you need more EEPROM, you can order an MC68HC805B6, which provides 6k bytes of EEPROM (and no ROM). Or you can select an MC68HC05B4 with 4k bytes of ROM. The MC68HC05B4 sells for $4 (OEM qty), and the MC68HC805B6 is available for $49.50 in limited quantities. For $500 you can order evaluation modules of the MC68HC05B6 for development support.—J D Mosley

COMMUNICATION SYSTEM PROVIDES SPEED AND FLEXIBILITY

Although you have many choices when looking for high-speed digital communication systems, the systems are incompatible, causing you to either buy from one vendor or develop your own hardware. The BPS/128 from Telestream Corp (Mountain View, CA, (415) 968-7977) provides a solution to this problem by giving you a programmable system that can operate on data streams in real time. Parallel-processing elements based on the AMD 29116 allow you to execute up to 160 MIPS on a data stream of 1.28G bps. You can use the BPS/128 on network applications such as protocol and format converters, multiplexers, cross-connect systems, and ISDN gateways. The company offers the BPS/128 with open architecture, allowing you to add your own proprietary hardware. System prices range from $15,000 to $50,000.—Doug Conner

FLOATING-POINT PACKAGE FOR 68HC11 AVAILABLE AT NO COST

With just a telephone call to Motorola Inc's (Phoenix, AZ) computerized bulletin-board system (phone (512) 440-3733), you can obtain the source code for a floating-point arithmetic software package that runs on the company's 68HC11 μC. The package takes slightly more than 2k bytes of code space plus 10 bytes of the μC's page-zero RAM. It performs addition, subtraction, multiplication, division, sine, cosine, and tangent operations. The software package also contains routines that perform conversions between floating-point and ASCII or floating-point and integer numeric representations. Floating-point numbers are represented in a proprietary format composed of a 1-byte exponent, a 3-byte mantissa, and one additional byte for the sign. All routines in the software package place temporary variables on the stack, allowing re-entrant programming.—Steven H Leibson

SURFACE-MOUNT-ASSEMBLY SERVICE MEETS MILITARY STANDARDS

It's hard to find an assembly house with fully automated assembly equipment for commercial surface-mount board designs; your problem is compounded if you're designing for the military environment. SMTEK (Chatsworth, CA, (818) 718-0380) can assemble a board to MIL-Q-9858. The company also offers its own design of a MIL-STD-1750A VHSIC-based computer board, which can be configured for your application; a representative price is $7000.—Margery S Conner

POWER CONVERTER SYSTEM BUILDS LOW-COST, ISOLATED OUTPUTS

By using one power IC to drive multiple output channels, Burr-Brown's (Tucson, AZ) PWS740 distributed, multichannel, isolated dc/dc converter system allows you to incorporate multiple dc output channels into your design with 1500V-ac isolation between channels. Three components comprise the system: the PWS740-1 oscillator/driver, which powers as many as eight channels and operates at 400 kHz; the plastic-encapsulated, trifilar-wound PWS740-2 isolation transformer; and the PWS740-3 high-speed bridge rectifier, which is packaged in an 8-pin DIP. These components cost $12.75, $2.50, and $1.25 (100), respectively. You use one PWS740-2 and one PWS740-3 per output channel. Each output channel can supply as much as 30 mA delivered at the voltage supplied to the PWS740-1's input within a range of 7 to 20V dc.—Steven H Leibson

PC-BOARD LAYOUT PROGRAM ACCOMMODATES 400 ICs, 30 LAYERS

Boasting a component library of more than 2000 TTL, CMOS, and μP components, the Schema-PCB design program from Omation Inc (Richardson, TX, (214) 231-5167 or (800) 553-9119) runs on IBM PC and compatible computers and works in conjunction with the manufacturer's Schema II schematic editor. Using Schema-PCB, you can design boards as large as 32×32 in. with as many as 30 layers.

The program offers 1-mil resolution on placement and tracking, autoplacement, air-gap and connectivity design-rule checking, autorouting with four separate accuracy algorithms, and schematic input and back annotation. You can define track width, pad size and shape, and enter engineering changes at the schematic level. Schema-PCB costs $975; it costs $1500 for both Schema-PCB and Schema II.—J D Mosley

GRAPHICS BOARD FOR MACINTOSH GIVES 1024×768-PIXEL RESOLUTION

If you use Apple's Macintosh II personal computer as an engineering tool, you can enhance its graphics capability with the $2795 ColorBoard 1/104 from RasterOps Corp (Cupertino, CA, (408) 446-4090). It increases the computer's screen resolution to 1024×768 pixels. Based on the company's proprietary ASICs, the single-slot board communicates with the Mac II's 68000 processor over the 32-bit NuBus.—Margery S Conner

ASIC LIBRARY GAINS 6805 CORE CPU

Through its alliance with Motorola Inc, NCR Microelectronics (Fort Collins, CO, (303) 226-9550) has added a 6805 core CPU to its 2-μm VS2000 supercell library (see EDN, September 3, pg 69). The 68C05 library supercell contains just the ALU portion of the 6805 μC, operates at clock speeds to 8 MHz, and executes all of that processor's instructions, including the 8×8-bit unsigned multiply instruction found in only some of the 6805 family of μCs. The CPU features a 16-bit address bus (up from the discrete part's 13 bits) and four uncommitted interrupt lines. Three of these interrupt lines became uncommitted when the discrete μC's timer and communications ports were stripped away to create the CPU core. NRE charges for an ASIC including the 6805 core start at $69,500.—Steven H Leibson

INDUSTRIAL PC BUS BOARDS INTEGRATE MULTIPLE FUNCTIONS

The MacroCard (MC) Series of PC/AT- and 80386-compatible multifunction boards for industrial applications is now available from Texas Microsystems (Houston, TX, (713) 933-1029). The MC-01 board has a SCSI hard-disk-drive controller; you can choose as much as 256k bytes of battery-backed RAM or 512k bytes of EPROM. The MC-02 lets you add as much as 512k bytes of nonvolatile RAM or 1M byte of EPROM. Both boards come with one parallel and one serial communications port, CGA/EGA/Hercules-compatible video outputs, and a floppy-disk controller. Each board plugs into a single PC/AT expansion slot, and pricing starts at $650 (100).—J D Mosley

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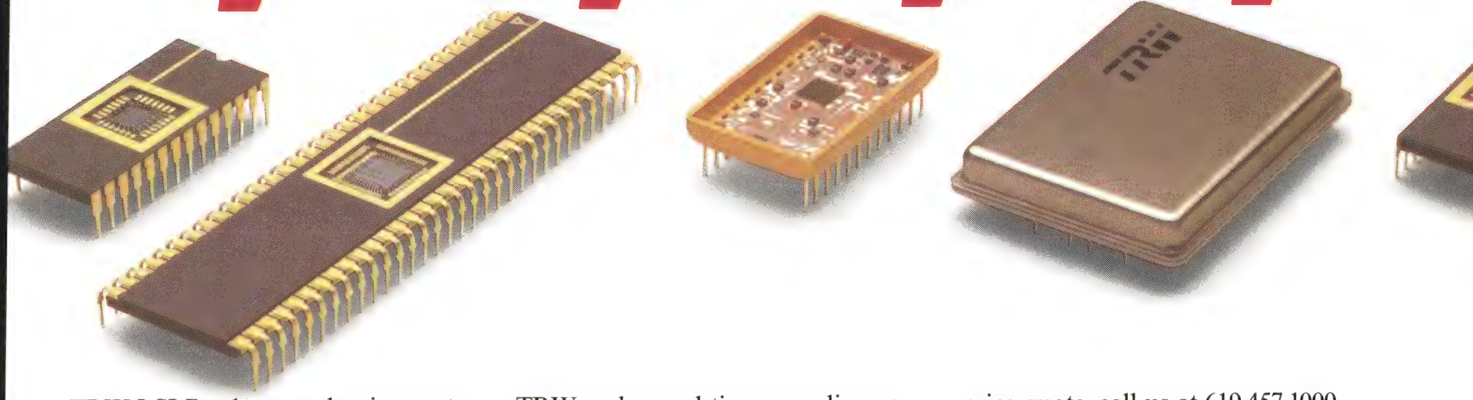

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TDC1020	Monolithic	10-bits	20MSPS

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CIRCLE NO 111

NEWS BREAKS: INTERNATIONAL

PREVIEW OF SALON DES COMPOSANTS EXHIBITION

Our primary coverage of the Salon des Composants exhibition, which will be held in Paris, France (November 16 to 20), begins on pg 109 in this issue. Some products that will be exhibited at the event, but which arrived too late to include in our primary coverage, are described below.

BiMOS PROCESS PRODUCES SINGLE-CHIP TELEPHONE ICs

By using a BiMOS process to mix analog and digital functions on a single chip, Mietec (Oudenaarde, Belgium, TLX 85739) has developed ICs for use at both ends of telephone lines. Incorporating a DTMF or pulse repertory dialer that supports on-hook dialing, speech circuits that provide 4-wire/2-wire conversion and background noise reduction, plus line impedance matching and load/gain regulation circuitry, the MTC2083 single-chip telephone IC interfaces telephone sets to PSTN or PABX networks. Its speech circuit incorporates an additional receive amplifier that you can use either to drive a loudspeaker or to increase the receiver gain in phones made for people who are hard of hearing. At the PABX or central-office end of the line, the MTC6042 provides a single-chip solution to many of the BORSHT functions of the subscriber line interface. These functions include a high- or low-ohmic-value battery feed, overpower, and 2-wire/4-wire conversion circuitry, and supervisory functions that monitor hookswitch status, ring-trip, and ground-wire conditions. It also has a driver for relay-operated or electronic ringing-signal injection circuitry. In volume, the MTC2083 and MTC6042 are priced at around £1.55 and £3, respectively. The devices will be shown in Hall 3, alley 35, stand 98.

VOICE-CHANNEL SCRAMBLERS INTERFACE TO μP SYSTEMS

You can internally switch the transmit and receive audio pathways in Consumer Microcircuits Ltd's (Witham, UK, TLX 99382; in the US, Mx.Com Inc, Winston-Salem, NC, (919) 7445050) FX-214, -224, and -234 variable split-band voice-scrambler ICs; you can then use them in half-duplex communications systems. Because the scramblers work by splitting the voice band into high- and low-frequency sections and frequency-inverting each section, the ICs also have an on-chip highpass filter to prevent interference from the subaudio frequencies used in continuous-tone-controlled squelch systems (CTCSS). You can program the devices to operate with any one of 32 different split-point/inversion-carrier frequency combinations, allowing you to implement fixed- or rolling-code scramblers. To control operation of the scrambler, the FX214 has a serial interface, the FX224 has a parallel interface, and the FX234 has both parallel and serial interfacing capability. The ICs cost approximately £9 (1000) each; you can see them in Hall 3, alley 34, stand 127.

DEVELOPMENT SYSTEM SUPPORTS THE 68HC11 MICROCOMPUTER

Ashling Microsystems Ltd's (Limerick, Ireland, TLX 70357) CT68HC11 PC-based development system supports software development for the Motorola MC68HC11 8-bit microcomputer. It provides real-time emulation of all three of the microcomputer's operating modes; an integral 70-bit-wide logic state analyzer allows you to trace activity on the microcomputer's address bus, data bus, control lines, and I/O ports. You can set as many as 64k read- and 64k write-address breakpoints, plus elapsed-time and external-signal breakpoints. An integral PROM programmer programs the on-chip EEPROM and configuration register of the 68HC11, and standard or paged EPROMs. The system, which typically costs between $5000 and $6000, includes a full-screen editor, a relocatable macroassembler, and software utilities that interface it with third-party C compilers. Ashling Microsystems will be at Hall 2, alley 21, stand 21.—Peter Harold

CAPTURE.

CREATE.

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Connected via the GPIB interface, the Nicolet Model 4094 digital oscilloscope teamed up with the Nicolet Model 42 arbitrary function generator provides instantaneous waveform storage and generation.

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Nicolet Digital Oscilloscopes

Incoming signals digitized by Nicolet's high accuracy 12-bit, 10 MHz digitizers or high speed 8-bit digitizers allow you to see things you've never seen before. Zoom expansion to X256 allows you to see the details in waveforms composed of up to 16k points. Cursor readout of measurement values, continuously variable pretrigger positioning, and built-in disk drives all contribute to Nicolet's tradition of measurement power and ease of use.

Nicolet Programmable Function Generators

NEW!

Outgoing signals are accurately generated from the 12-bit by 2k arbitrary waveform memory in the Model 42. Real-time duplication of the captured signal can be produced at speeds up to 1 μSec per data point.

Continuous, triggered, gated, and burst output modes are possible. A unique feature, arbitrary sweep, allows you to accurately program the output frequency. Standard waveforms (sine, triangle, square, sawtooth, pulse), 10 $mV_{p\text{-}p}$ to $20V_{p\text{-}p}$ amplitudes, are all available at speeds up to 4 MHz.

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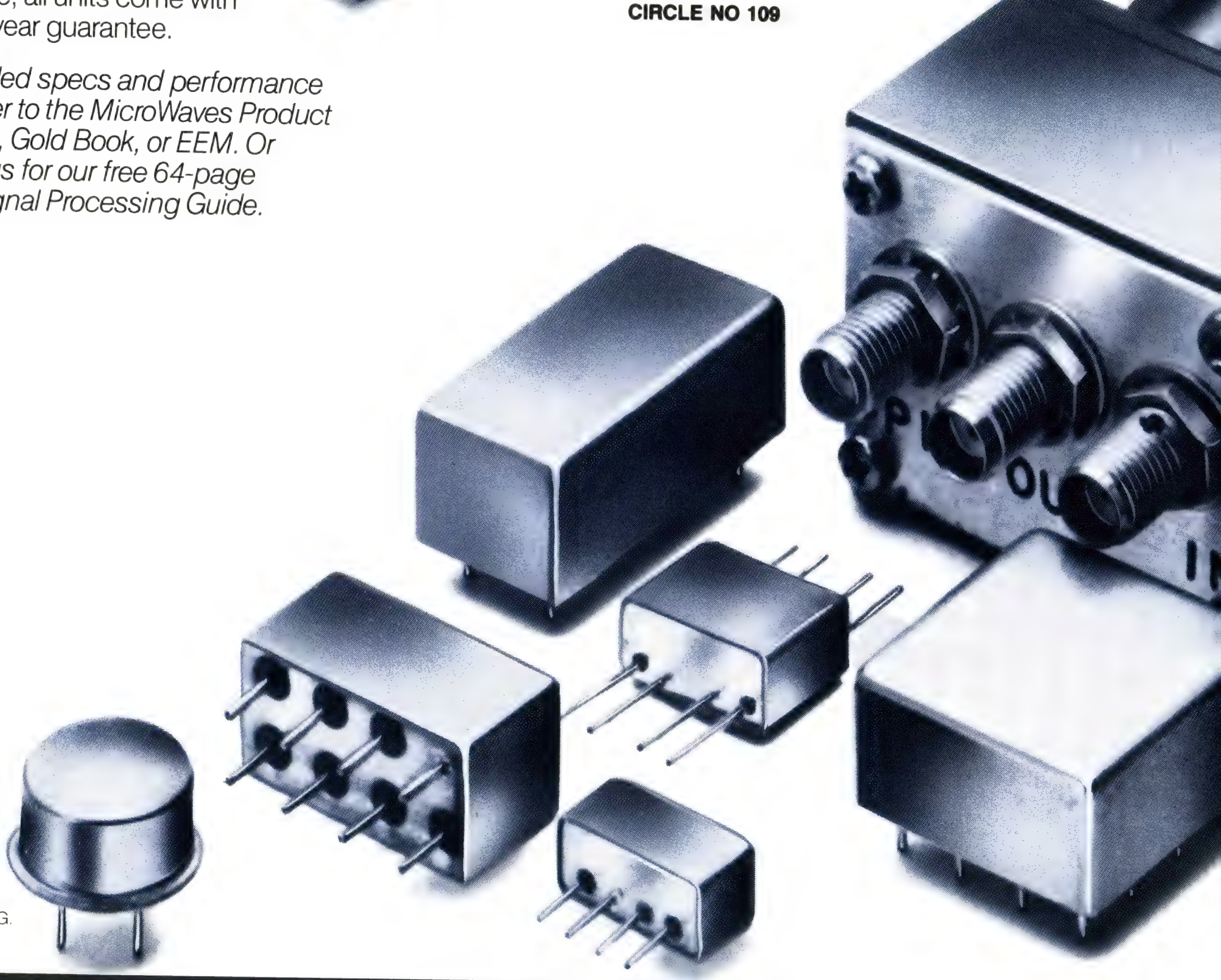
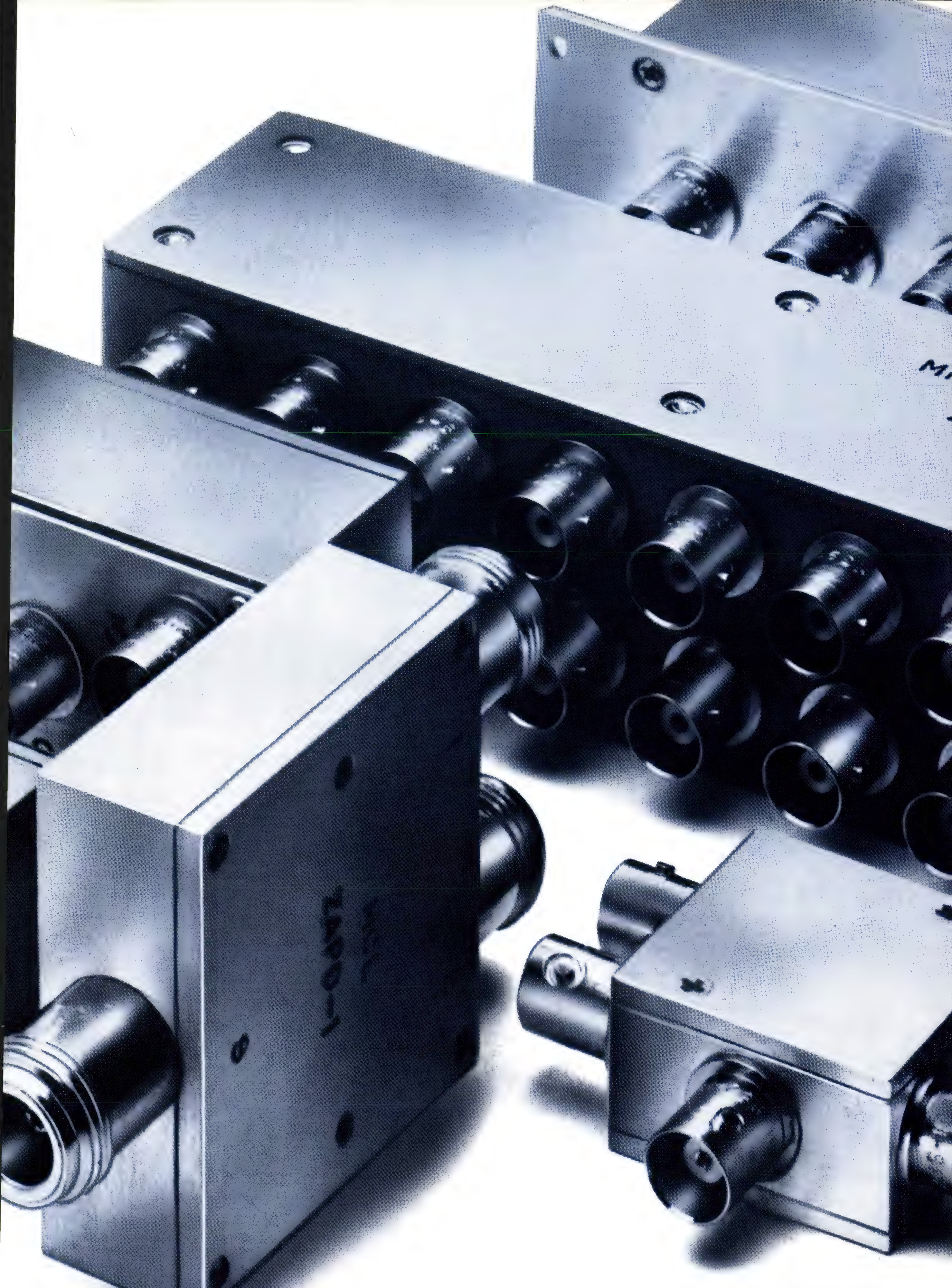
CIRCLE NO 109

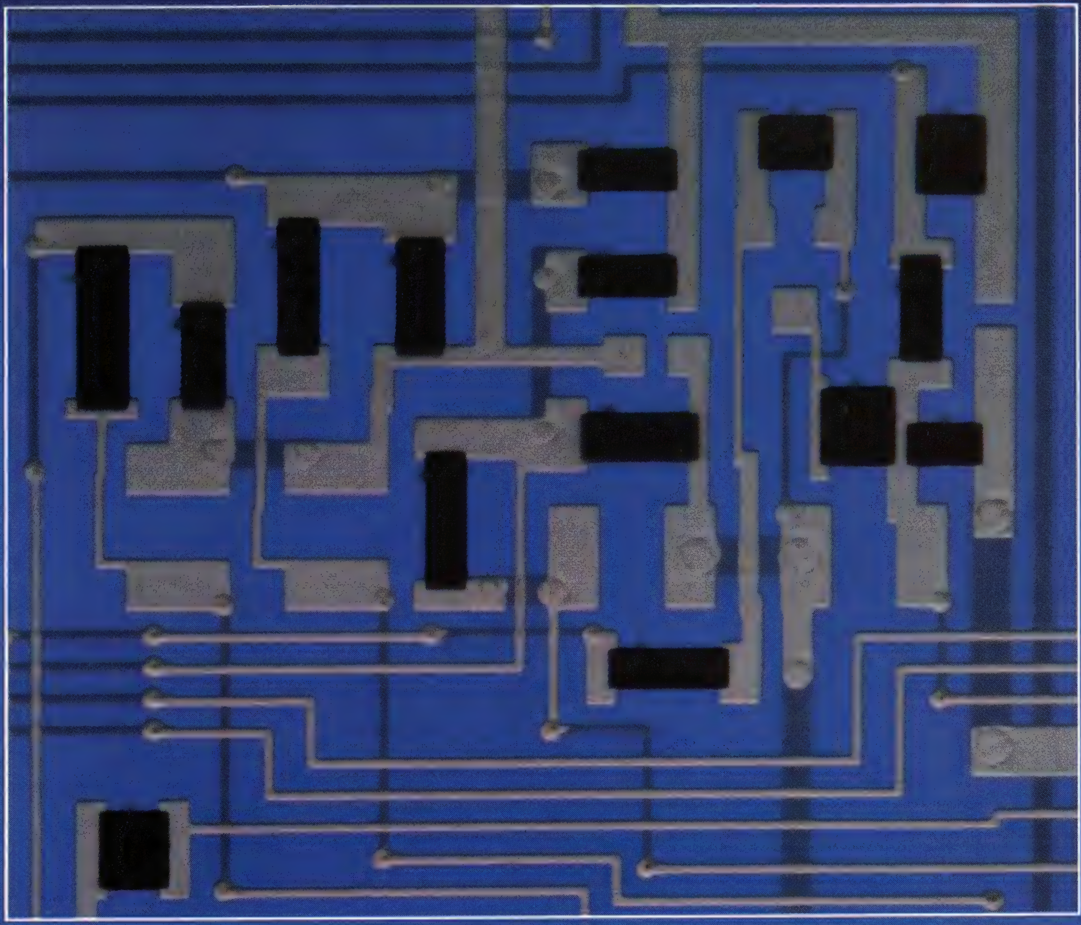


C107-1 REV. ORIG.



C107-2 REV. ORIG.

Du Pont's Palladium/Silver
High density.



Only Du Pont has a Palladium/Silver System that delivers 0.5%* stability on top of dielectric.

If you want to free up valuable real estate but are concerned about sacrificing performance, Du Pont's coordinated Palladium/Silver Hybrid Materials System is the answer.

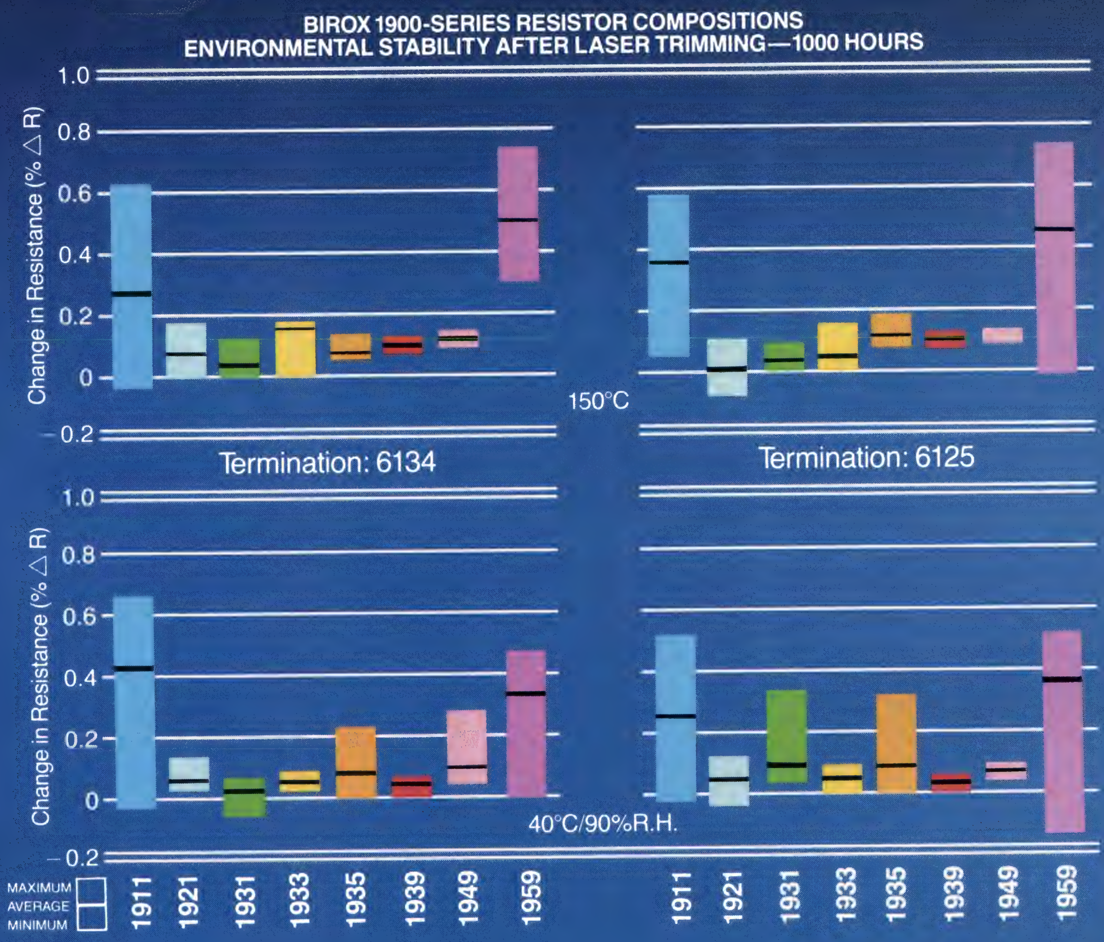
The designed-in compatibility of our BIROX® 1900 Series resistor compositions, 6134 and 6125 Palladium/Silver Conductors and 5704 Dielectric, delivers total system performance, lot after lot, run after run, without "mix and match" problems.

The BIROX 1900 Series thick film resistor compositions are the key. Consistent resistor performance with average end-of-life stabilities of 0.5% or better is just the beginning.

Fireable in a fast 30-minute profile, the resistors make laser trimming over the system dielectric as simple as laser trimming over alumina. Tight, reproducible post-trim distributions with TCRs of 0 ± 100 ppm/°C are a real advantage. And because these resistors are screened onto the 5704 Dielectric surface, you can build up in the Z dimension as well as out in the X and Y directions. This means denser circuits and

E-89239 11/86 Printed in U.S.A.

Multilayer System. High confidence.



BIROX 1900-SERIES RESISTOR COMPOSITIONS
ENVIRONMENTAL STABILITY AFTER LASER TRIMMING—1000 HOURS

greater design freedom.

As for conductor performance, Du Pont's 6134 and 6125 Palladium/Silver Conductors resolve better than 10-mil lines to maximize circuit density while excellent solder wetting and aged adhesion assure high-yield assembly and dependable component attachment.

Du Pont's 5704 Dielectric completes the system. Circuit performance benefits from its low K (9–10). And with the TCE matched to alumina, substrate bowing is minimized even through multiple firings. 5704 prints at 6 in/sec for high productivity and resolves 8- to 10-mil vias for increased density.

The combination of superior product performance and Du Pont's commitment to manufacturing quality delivers a Palladium/Silver Hybrid Materials System with high density and high confidence.

To learn how Du Pont's Palladium/Silver Hybrid Materials System can solve your packaging problems, call 1 800 441-7543. Or write: Du Pont Company, Electronic Materials Division, Room X50533, Wilmington, Delaware 19801.

*Typical average stability after 1,000 hours on a trimmed 40 mil × 40 mil resistor.

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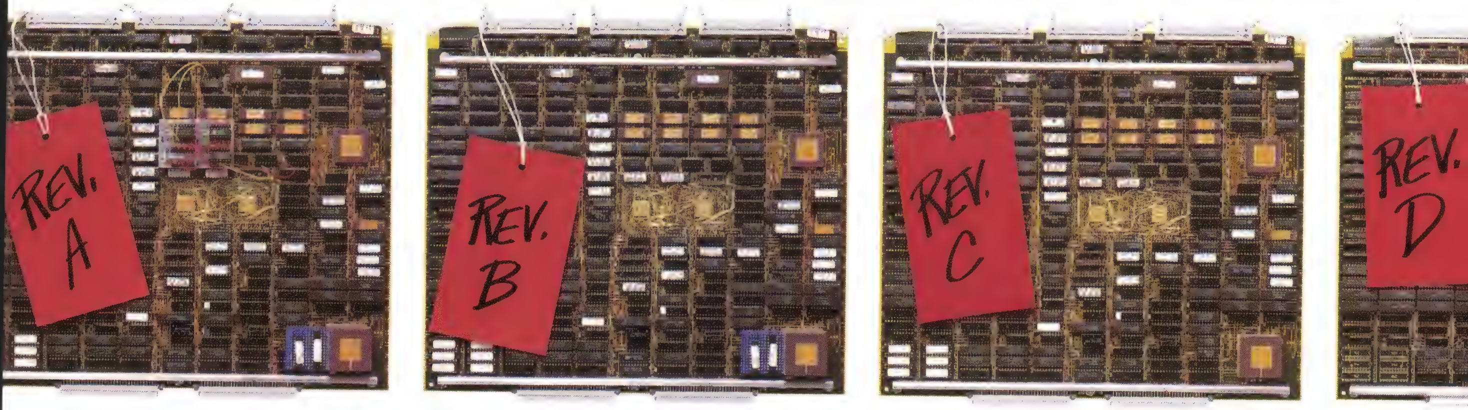
CIRCLE NO 108

ONE PROTOTYPE
THREE PRO
FIVE PROTOTYP
SEVEN PRO



Teradyne's new CAE tools help you get to market faster b

Designing VLSI circuit boards that work the first time isn't child's play. You can't do it without fast, accurate feedback on design and test quality.

Now count on Teradyne to help. With our new family of CAE products, you'll uncover flaws before they're cast in hardware. So you'll be able to jump from initial design directly to final prototype. And from design to manufacturing test.

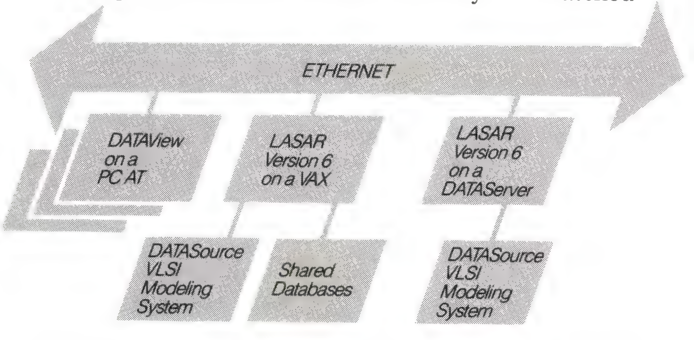
Start with a firm design foundation.

The process starts with DATAView our new design entry system. Running it on a standard AT-class PC, you can control the whole design process right at your desk. From schematic entry and waveform analysis on the PC to simulation and fault simulation on more powerful networked computers. All with the same mouse-and-menus, multiple-window interface.

You move from schematic capture to simulation effortlessly. DATAView's links with our LASAR Version 6 simulation system save hours of model compilation time. Incremental compiling lets you revise a design and resimulate in minutes.

Make your design work together before it comes together.

LASAR Version 6 is the only sure way to avoid multiple trips to artwork as well as costly rework steps in manufacturing. Because its simulation accuracy is unmatched


ETHERNET
DATAView on a PC AT
LASAR Version 6 on a VAX
LASAR Version 6 on a DATAServer
DATASource VLSI Modeling System
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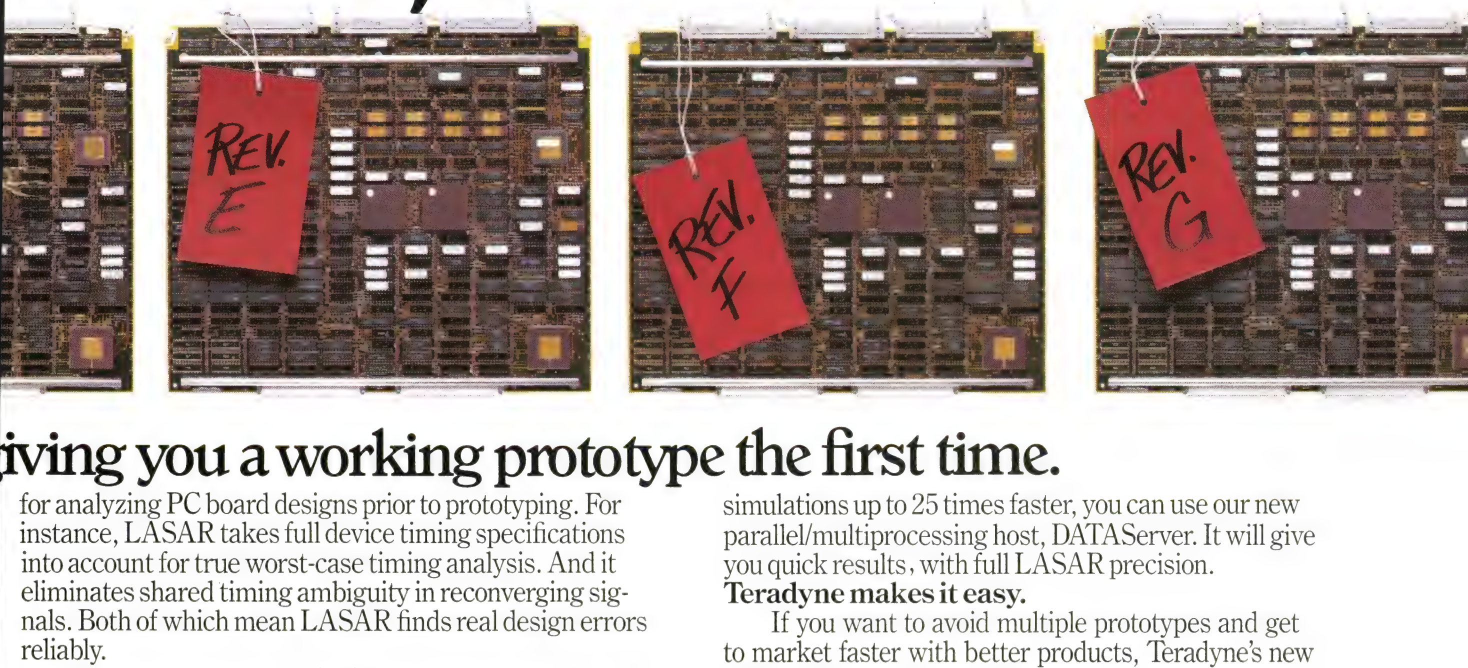
Teradyne networks advanced CAE tools for convenience *and* performance.

WO PROTOTYPE, TYPE FOUR. SIX PROTOTYPE, TYPE, MORE.



iving you a working prototype the first time.

for analyzing PC board designs prior to prototyping. For instance, LASAR takes full device timing specifications into account for true worst-case timing analysis. And it eliminates shared timing ambiguity in reconverging signals. Both of which mean LASAR finds real design errors reliably.

Finally, you can use LASAR fault simulation. It will uncover testability problems and untested circuit functions before it's too late.

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LASAR also takes care of the board modeling problem. It includes models of over 4000 devices. And the most popular gate array libraries.

For new VLSI parts, our DATASource hardware modeling system uses actual devices instead of software models. A single system supports multiple users and concurrent fault simulation. With extraordinarily fast response.

LASAR and DATASource work with any VAX. For simulations up to 25 times faster, you can use our new parallel/multiprocessing host, DATAServer. It will give you quick results, with full LASAR precision.

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If you want to avoid multiple prototypes and get to market faster with better products, Teradyne's new CAE system is the way. Why not call Daryl Layzer at (617) 482-2700, ext. 2808 for more information. Or write Teradyne, 321 Harrison Avenue, Boston, MA 02118.

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CIRCLE NO 132

SIGNALS & NOISE

Poor business practice is biggest US export obstacle

In his editorial entitled "Loosen export restrictions" (EDN, June 25, pg 59), Jon Titus stated that US export regulations are the main obstacle to US export.

The regulations are a barrier for sure, but there are some much bigger problems with shopping in the US. Here are a few examples from the point of view of a Swiss electronics company:

1. When I buy 1000 RAMs in the US, I get (with luck) 990 good parts. When I buy 1000 RAMs in Japan or Europe, I get 1000 good parts. Companies in Japan and Europe have a zero-reject, zero-defect philosophy.

2. US salesmen don't speak any language other than English. Can they do sales promotion in English in Switzerland or France? Further, they don't know how non-US customs works, nor are they informed about shipping. They send me a 1-kg package by air freight collect, although prepaid air parcel is six times cheaper and much faster, and it passes customs control without paperwork for the customer.

"I WOULDN'T BE CONCERNED, FRANK. THE ROBOT WON'T GET FAR."

3. It takes US companies weeks—not days—to respond to a telex or fax request. Using the phone is sometimes not possible because of the 6- to 11-hour time difference (I leave the office when they start working). Even bigger companies have no telex or fax capability.

4. It takes a US bank four to eight weeks to validate a non-US banker's check. In Europe, the same procedure takes one to two working days.

5. US companies almost never confirm orders in a reasonable amount of time, and they take a few days or even a few weeks to answer a quotation request. Why isn't the procedure instant? Is the Pentagon the only US organization that has a computer?

6. Ordering goods and equipment in metric units creates confusion in US sales offices. Why does a US company send me an aircraft altimeter calibrated in inches mercury

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CIRCLE NO 3

MT STANDARDS.

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Sprague Type 195D and 293D solid tantalum chips meet the brand new EIA size and packaging standards for surface mount capacitors. These miniature components fill your surface mount needs with economy, reliability and high performance. Conformal-coated Type 195D TANTAMOUNT® capacitors meet EIA specifications for Extended Capacitance Range devices. These units feature gold or solder plated terminals and the highest capacitance in the smallest packages available in the industry. Rugged, fully molded Type 293D TANTAMOUNT® capacitors conform to EIA specifications Standard Capacitance Range vices. These "machine-friendly" tantalum chips are compatible with all automatic placement equipment. Both types supplied taped and reeled per EIA 481A. Standard ratings: 0.10 to 100μF, 4 to 50 WVDC. *Sprague Electric Company, xington, MA.* For "Quick Guide To Tantalum Chip Capacitors", ASP-642, write to Marketing mmunications, Sprague Electric Company, P.O. Box 9102, Mansfield, MA 02048-9102. For plications assistance, call our Customer Service Center at Concord, NH at 603/224-1961.

CIRCLE NO 131

SPRAGUE
THE MARK OF RELIABILITY

when I ordered it in hectopascals?

7. Export works quite well from such historical trade centers as New York and Boston, but as soon as you go a few miles from the coast, things get worse. Some companies have no export experience.

I buy in the States, but only if I have to. It's difficult to deal with the average US company, not mainly because of export licenses, as Jon Titus states, but because of the above-mentioned communication, education, and service problems.

We in Europe, and others too, would have considerable problems in the world markets if the US had the same power in export that it has in its inland market.

Perhaps Mr Titus could entitle his next export article "Loosen export potential."

Chris Moser
Mostec Inc
Liestal, Switzerland

Company doesn't require minimum orders

The May 28 issue of EDN contained an excellent technology update by Chris Everett ("Smaller, cheaper silicon pressure sensors are starting to appear on vendors' shelves," pg 83). Chris is knowledgeable in the field and the update was an excellent review of the area.

The piece did contain an error, however—it indicated that NovaSensor would not accept orders for quantities smaller than 10,000 pieces. This is incorrect. The statement apparently comes from a product release on our silicon sensor die-level product. For these die-level sensors, our minimum is indeed 10,000 pieces, although occasionally we have taken smaller orders.

However, NovaSensor has a full line of sensors and microstructures. None of these other products has a minimum requirement.

Joseph R Mallon Jr
NovaSensor
Fremont, CA

Product notes

Please note these changes to the Hardware and Interconnect section of EDN's July 9 Product Showcase. First, the LSI Microseries Model 13/23K optical encoder (from Litton/Itek Encoder) described on pg 222 and 224 costs $1650, *not* $16.50. Second, the Recortec rack enclosure described on pg 222 as the KBD-100 is actually called the RME-100.

WRITE IN

Send you letters to the Signals and Noise Editor, 275 Washington St, Newton, MA 02158. We welcome all comments, pro or con. All letters must be signed, but we will withhold your name upon request. We reserve the right to edit letters for space and clarity.

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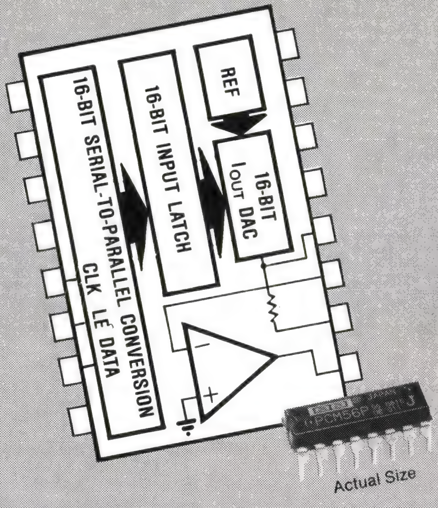

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TEXAS INSTRUMENTS REPORTS ON

NETWORKING

N THE ERA OF

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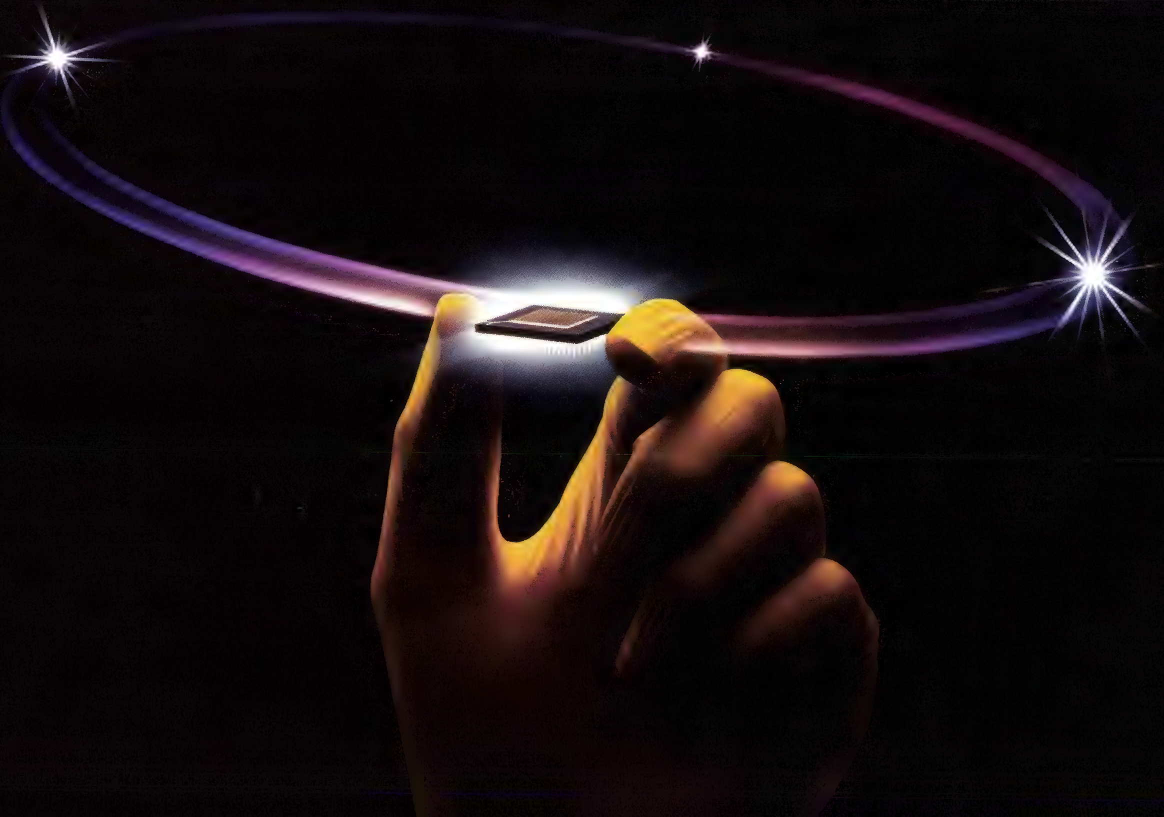


Networking in the Era of MegaChip Technologies:

When connecting to the you need to connect with

Only the TMS380 Chip Set from Texas Instruments is tested and verified with IBM. That frees you to concentrate on the

Industry observers agree: The IBM® Token-Ring Network is capturi

BM Token-Ring,
exas Instruments first.

om Texas Instruments." All you need to
pitalize on the growing demand for
oducts that will operate on the ring is
design with TI's TMS380 Chip Set.

**Ve use TI's TMS380 Chip
et and TI's implementation of
EEE 802.2 LLC protocols to
nsure IBM compatibility at
edia-access and software levels."**
hat is Howard S. Charney, senior vice
esident of 3Com Corporation, stating

the chief reason for turning to TI first when designing-in token ring connectivity. You know your TMS380-based product will be 100% compatible with IBM and industry standards.

As a result, you avoid any problems of validation, verification, or long development time. You gain time to add product enhancements that can mean a competitive edge in the marketplace.

Martin Sinnott, director, Dayton Development Center of the NCR Corporation, sums up the advantage this way: "We offer the very highest level of interoperability with the IBM Token-Ring Network via TI's TMS380 Chip Set and our own software."

An integrated solution for "open" systems

TI's TMS380 Chip Set begins with a 40-million-bits-per-second DMA interface. This provides efficient connection to high-speed microprocessors such as Intel's 80X86 and Motorola's 680X0 families and open-system buses like IBM's Micro Channel™ and Apple's NuBus™.

Having built-in software jointly copyrighted by IBM and TI, the TMS380 provides all IEEE 802.5 media-access control processing, including on-board network-management services *(see box)*. In addition, the TMS380 provides capability for message-buffer expansion and higher layer protocols, such as IBM-compatible IEEE 802.2 Logical Link Control (LLC), available from TI.

The TMS380 completes your connection to the IBM Token-Ring with physical-layer interface circuits that provide clocking, data reception and transmission, and ring-insertion control.

Opening the way to internetworking the TMS380 facilitates the design of token ring bridge and gateway products.

Good news about cost

Another reason to choose the TMS380 is that the cost of connectivity is coming down. The chip set is available now at a suggested resale price under $100.00 (quantity 100).

The TMS380 reflects the influence of TI's MegaChip™ Technologies. These are the skills and disciplines acquired through ongoing development of high-density circuits which generate advances in semiconductor design, processing, manufacturing, and service.

These technologies are having an effect on other LAN standards. For example, TI has developed the SN75061/62 single-channel drivers/receivers that can easily be configured for use with StarLAN IEEE 802.3 1BASE5 networks. These new devices perform data transmission/reception and minimize transmission-line noise. The SN75061 is ideally suited to 1BASE5 stations; the lower-power, lower-cost SN75062, to hubs.

For more information on the broad TMS380 support, turn the page.

Reliable network management

"We have designed our ProNET®-4 product using the industry-standard TI TMS380 Chip Set. In addition to normal data-communications functions, the chip set provides power-up self-test as well as network-management frames for automatic error detection, parameter services, and reconfigurations. The net effect is reliable, manageable network operation."

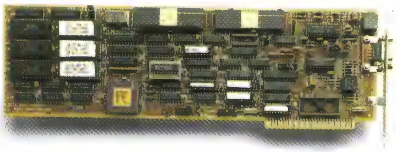
Howard Salwen,
Chairman and Founder, Proteon, Inc.

Comprehensive support from TI speeds TMS380 design-in.

TMS380 Adapter Chipset User's Guide
Local Area Network Products
TMS380 Token Ring Adapter Bring-Up Guide
Texas Instruments

To help you with everything from token ring adapter-card prototyping through communications-protocol development and systems integration, TI makes available the comprehensive TMS380 Development Products Family.

Design-in Accelerator Kit includes hardware and debug software for completing a prototype token ring adapter: Three sample TMS380 chip sets, engineering debug software with User's Guide, and an interconnect schematic.



PC Adapter Card helps you develop software and analyze traffic on the IBM Token-Ring Network. It works in both the PC Family and PC AT compatibles and incorporates TI's new IEEE 802.2 LLC. The card comes with demonstration software as well as protocol-analysis software to help develop your communications protocol.

Test Wiring Concentrator (TWC) provides the mechanism for any station to be inserted on the ring and adds LEDs that indicate ring insertion.

TMS380 LLC EvaluationKit provides the hardware, software, and documentation required to evaluate the IBM-compatible IEEE 802.2 LLC software on your designs.

ASIC-LAN Tool Kit enables the fast development of highly integrated, differentiated, and compact adapters. The kit contains ASIC software macro building blocks and completed design examples. These support Adapter Memory Expansion and PC Bus Interface. The kit not only helps save board space, but also several months of system and hardware design.

TMS380 Bridge Design Kit contains one TMS38021 Bridging Protocol Handler, one set of Bridge Options Adapter Software, and a TMS38021 Bridge Application Report to help you develop bridge or gateway products.

Token Ring Seminars are conducted on request at TI Regional Technology Centers or at your site. A two-day workshop includes an introduction t the TMS380 Chip Set and hands-o experience in the lab. A one-day TMS380 Advanced Topics Worksho provides an understanding of the extended LLC interface on the TMS38 and provides insight into bridge applications.

For more information on TI's TMS380 Chip Set, call TI's hot-line number, **(713) 274-2380.** Or compl and return the coupon today to Texa Instruments Incorporated, P.O. Box 809066, Dallas, Texas 75380-9066.

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CIRCLE NO 151

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1 **1 GHz.** The 11402 Digitizing Oscilloscope features a full 1 GHz bandwidth right on the probe tip to help you make the most demanding voltage and timing measurements.

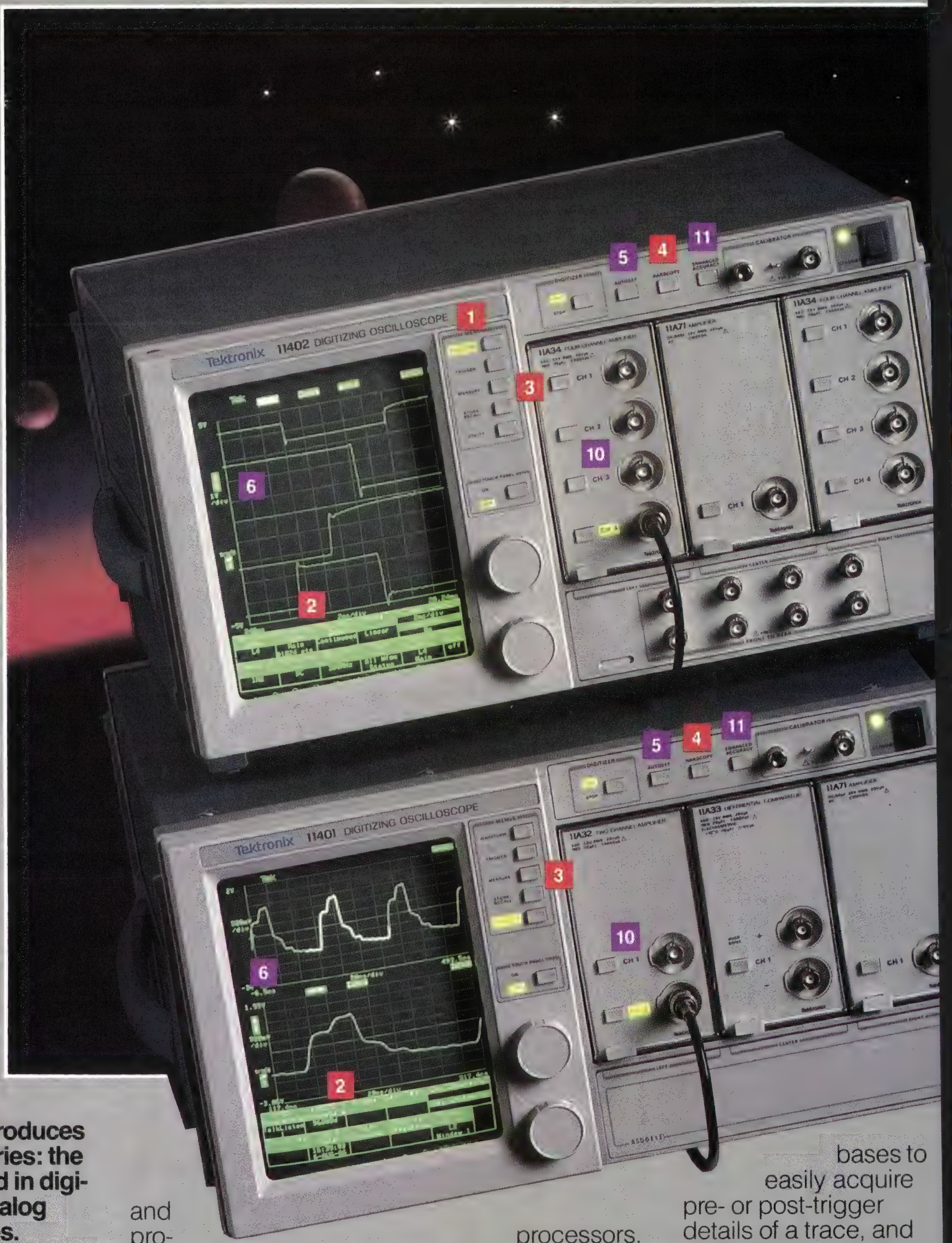
2 **10-14 BIT VERTICAL/ 10 ps HORIZONTAL RESOLUTION.** 10-bit vertical resolution is averageable to 14 bits. Self-calibration decreases error to less than 1% DC.

3 **AUTOMATIC MEASUREMENTS.** Up to six measurements can be made at the push of a button, with results simultaneously displayed and continuously updated.

4 **PUSH-BUTTON HARD COPY.** Plug in a Tek or compatible Epson dot matrix printer using the scopes' standard Centronics port.

5 **AUTOSET.** Push a button on the front panel or on the probe to automatically set up the scope based on the signal characteristics of the selected trace.

6 **TOUCH SCREEN.** Select a trace, a trigger, a measurement or other function by touching the appropriate area of the screen or by selecting from pop-up menus: the closest, most natural link yet between user and scope.


Tektronix 11402 DIGITIZING OSCILLOSCOPE
Tektronix 11401 DIGITIZING OSCILLOSCOPE
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11A71 AMPLIFIER
11A32 TWO CHANNEL AMPLIFIER
11A33 DIFFERENTIAL COMPARATOR
CALIBRATOR
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2
3
4
5
6
10
11

THE NEW ERA IN DIGITIZING AND ANALOG OSCILLOSCOPES.

Tektronix introduces the 11000 Series: the new standard in digitizing and analog oscilloscopes.

These new fully programmable scopes display more traces (up to 8) at higher bandwidths (up to 1 GHz), with greater accuracy (up to 0.6% vertical), and include more new functions for expediting the capture and processing of data than can ever be listed here.

Two new digitizing scopes exert the power of three 16-bit processors, long records, the most powerful triggering and the highest throughput ever. Use their built-in dual timebases to easily acquire pre- or post-trigger details of a trace, and view both the whole trace and the details on screen at once.

Two analog scopes feature an integrated 500 MHz universal counter/timer for unequaled resolution, accuracy, and scope versatility— for the

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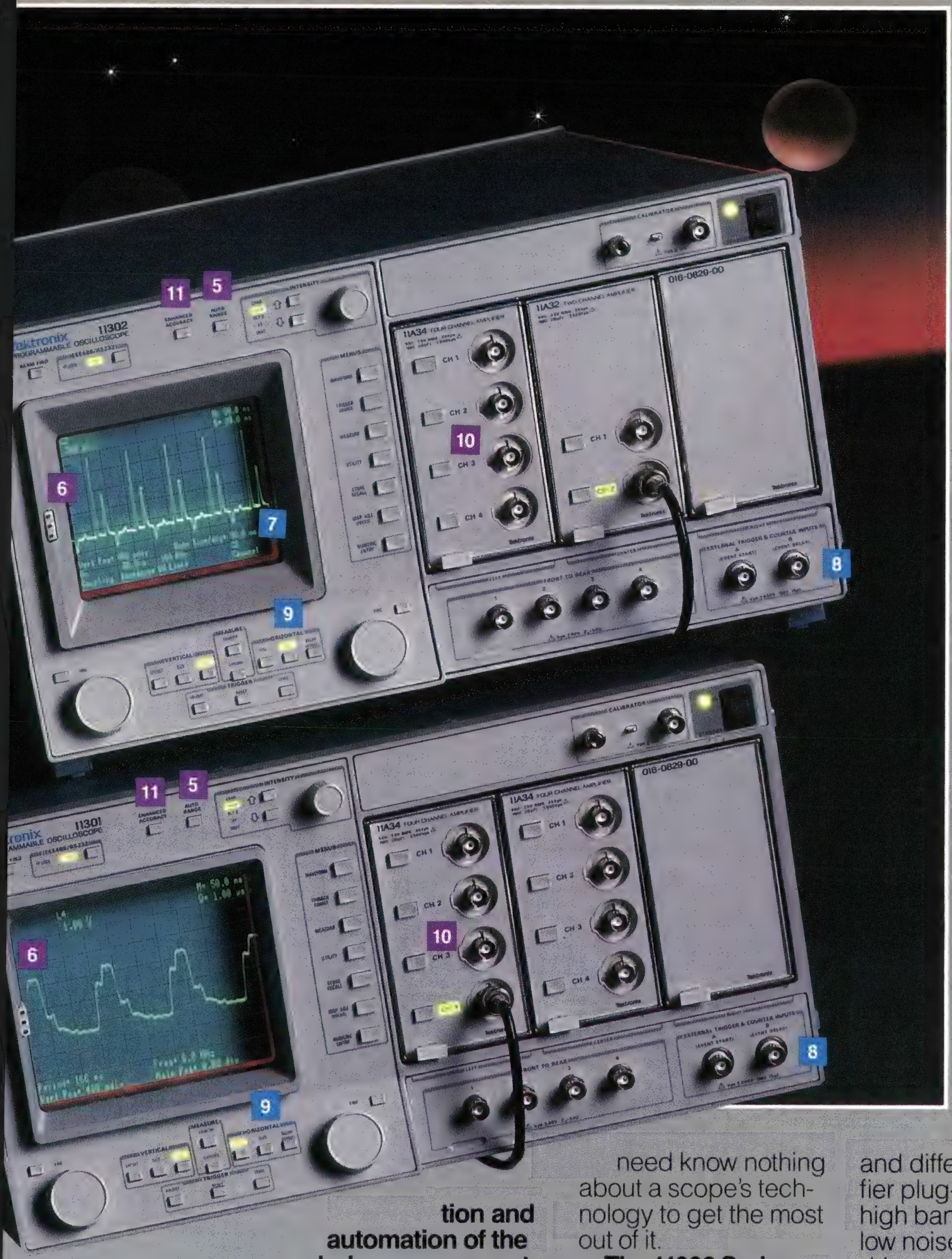
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11
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ANALOG

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8 500 MHz INTEGRATED COUNTER/TIMER. Use with dual delayed sweeps for precise timing measurements between selected points. Unique counter view trace lets you see exactly what you are triggering on.

9 CURSORS. Use to make precise measurements on any part of a displayed waveform.

10 1 mV/DIV SENSITIVITY. Achievable from four new plug-ins. These amplifiers feature fast overdrive recovery and wide dynamic range.

11 SELF-CALIBRATION. Push the Enhanced Accuracy button to calibrate the scope from amplifier input to CRT graticule, automatically, for the best vertical accuracy available in a scope today.

price of a scope alone. A unique counter view trace lets you see exactly what you are triggering on, for a sense of confidence no conventional counter/timer can offer.

Perhaps most startling is the simplification and automation of the whole measurement and analysis process. Larger displays, pop-up and touch-screen menus, plus automated setup and measurement capabilities help unclutter the front panel and keep eyes focused on the display. For the first time, users need know nothing about a scope's technology to get the most out of it.

The 11000 Series continues the plug-in versatility of the Tek 7000 Series. Five new plug-ins and three new probes tailor the new scopes to a full range of applications, from design and debug to production test. New single-ended amplifier and differential amplifier plug-ins combine high bandwidth with low noise and fast overdrive recovery.

Demonstrations are now in progress. For more information or a personal demonstration, get in touch with your local Tek sales engineer. Or call Tektronix at 1-800-547-1512.

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CIRCLE NO 150

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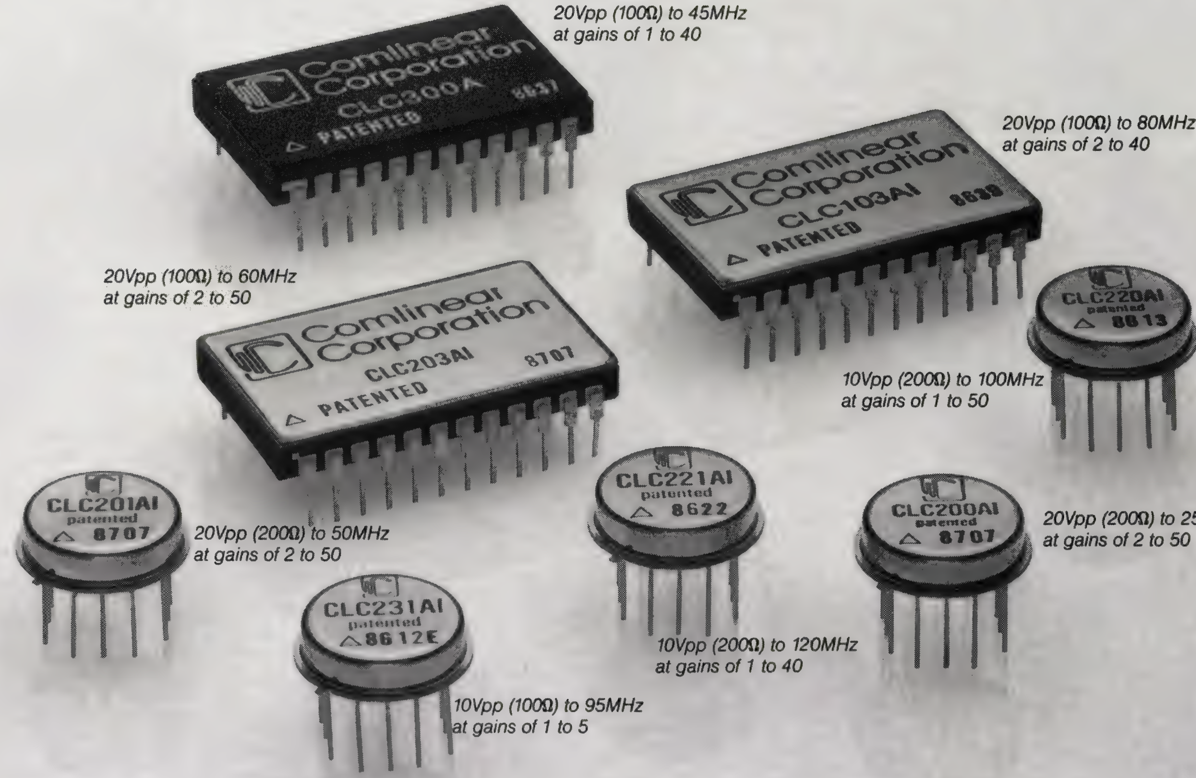

20Vpp (100Ω) to 45MHz at gains of 1 to 40

20Vpp (100Ω) to 80MHz at gains of 2 to 40

20Vpp (100Ω) to 60MHz at gains of 2 to 50

10Vpp (200Ω) to 100MHz at gains of 1 to 50

20Vpp (200Ω) to 50MHz at gains of 2 to 50

10Vpp (200Ω) to 120MHz at gains of 1 to 40

20Vpp (200Ω) to 25MHz at gains of 2 to 50

10Vpp (100Ω) to 95MHz at gains of 1 to 5

with these high-speed, high-drive op amps from Comlinear

With this op amp family, you don't sacrifice speed for gain. . . or for power. Because Comlinear designs eliminate traditional performance tradeoffs. Check the specs.

But there's more than performance. You also get complete min/max and over-temperature specifications. DC and AC parameter testing on every part. Unmatched ease of use (all are unity-gain stable, without compensation). Plus evaluation boards and top-notch design support. Which adds up to design productivity and confidence.

To expand your bandwidth, call (303) 226-0500 today. Or write Comlinear Corporation, 4800 Wheaton Drive, Fort Collins, Colorado 80525.

SPECIFICATIONS (Typical)

	−3dB Bandwidth (MHz) $A_v = 4$	$A_v = 40$	Settling Time to 0.1% (nsec)	Slew Rate (V/μsec)	Output (±V, mA)
General Purpose					
CLC103	170	130	10 (to 0.4%)	6000	11,200
CLC200	100	90	18	4000	12,100
CLC220	200	160	8	7000	12,50
CLC300	105	70	20	3000	10,100
Low Offset ($V_{OS} \lesssim 1$mV, 10μV/°C)					
CLC201	100	90	18	4000	12,100
CLC203	180	130	15 (to 0.2%)	6000	11,200
CLC221	200	120	15	6500	12,50
CLC231[1]	165 ($A_v = 1$)	120 ($A_v = 5$)	12	3000	11,100

Comlinear
Corporation

087101

CIRCLE NO 149 for general purpose op amp information **CIRCLE NO 188** for low offset op amp information

In the grand design of VME, where do we fit in?

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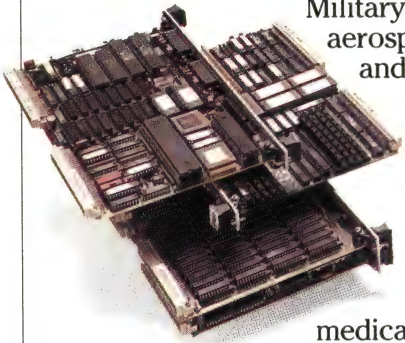

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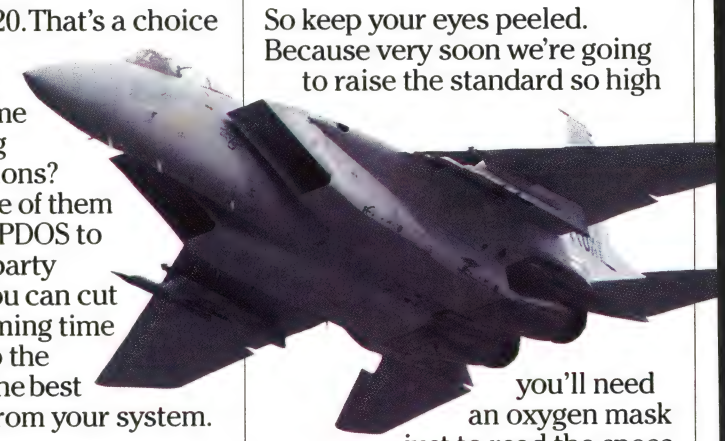

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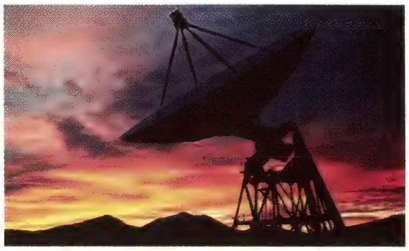
When it comes to performance, we're really not sure. We set new standards with our 68000-based CPU boards. Then we raised them with our CPU 20 and 21 designs. Giving you a 68020 running at a sizzling 25MHz with zero wait states. And a zero wait 80386 running at 16MHz.

Actually, we look at VME performance as a constant challenge. It's the closest thing we know to perpetual motion.

So keep your eyes peeled. Because very soon we're going to raise the standard so high you'll need an oxygen mask just to read the specs.

Quality you can rely on.
All the performance in the world is useless if it's based on a 3% return rate. With Force, you'll get



performance that lasts. Because our standards are based on NATO guidelines. And our Q/A policies are merciless. Every board is 100% in-circuit tested. Then 100% functional tested. And, as if that's not enough, they're put through 100% dynamic burn-in. No wonder our return rate is less than 0.9%. And dropping fast.

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As you might expect, our support is as uncompromising as our quality. Take our documentation. It's the most thorough and detailed in the business. Applications support? No one else delivers it faster or better. Just need a question answered? Call Force and you'll get somebody who's really qualified to help.

You can always get what you want.
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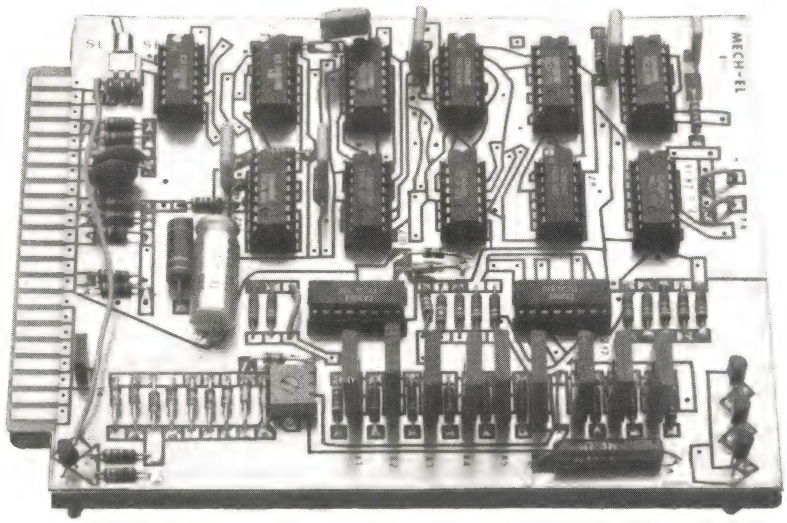

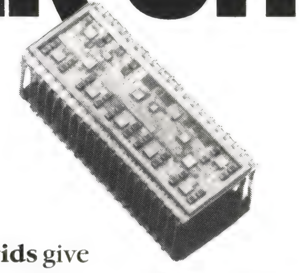

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Paine thick film hybrids give you real estate of bantam proportions. The circuits pictured have the same capability, but you could fit *48* of the hybrids on the bottom onto the board on the top. That's a lot of space on a 10,000-unit production run.

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Designing Signal Processors with DSP and Bit-Slice Chips (short course), Washington, DC. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. November 3 to 6.

Hands-On Microprocessor Software, Hardware, and Interfacing (short course), Los Angeles, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. November 3 to 6.

Troubleshooting Microprocessor-Based Equipment and Digital Devices, Atlanta, GA. Micro Systems Institute, 73 Institute Rd, Garnett, KS 66032. (800) 247-5239; in KS, (913) 898-4695. November 10 to 13.

Advanced SMT Design Techniques (short course), San Jose, CA. Surface Mount Technology Plus, 1786 Technology Dr, San Jose, CA 95110. (408) 943-0196. November 16 to 17.

Designing Signal Processors with DSP and Bit-Slice Chips (short course), Anaheim, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. November 17 to 20.

Troubleshooting Microprocessor-Based Equipment and Digital Devices, Norfolk, VA. Micro Systems Institute, 73 Institute Rd, Garnett, KS 66032. (800) 247-5239; in KS, (913) 898-4695. November 17 to 20.

9th Interservice/Industry Training Systems Conference, Washington, DC. Ralph Nelson, ADPA, Rosslyn Center, Suite 900, 1700 N Moore St, Arlington, VA 22209. (703) 522-1820. November 30 to December 2.

Hands-On Graphics Programming Using GKS/VDI Tools, Washington, DC. Integrated Computer Systems, Box 3614, Culver City, CA

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Here's a range of precision counters that lead the field in stability, capability and economy: Philips PM 6660 series.

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Each counter has a frequency range of 0.1Hz to 120MHz (1.1GHz optional); the ***PM6665*** *and* ***PM6666*** *Timer/Counters have 9 measuring functions and time interval averaging with a resolution down to 20ps, while the* ***PM6669*** *Frequency Counter offers 8 measuring functions, including frequency difference.*

The top-of-the-range PM6666 is fully programmable via GPIB - including trigger levels, sensivity ***and*** *all input settings. It also features V_{max}/V_{min} measurements as well as auto-trig level setting with guaranteed triggering for all input signals above 100Hz.*

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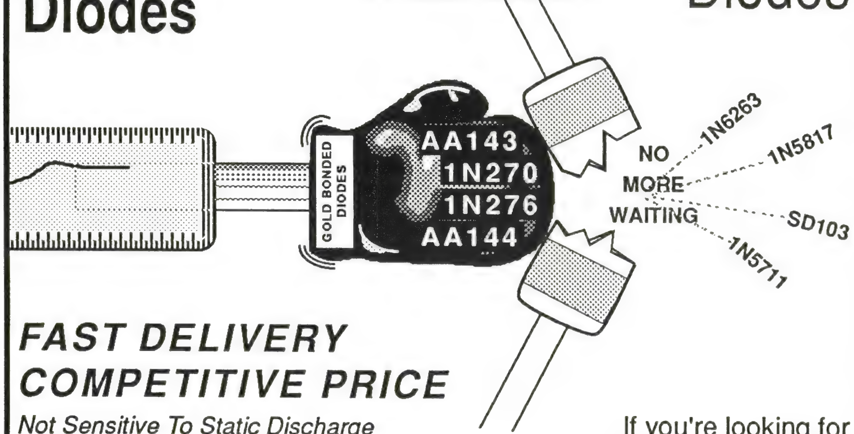

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Not Sensitive To Static Discharge
Operate at Lower Current Level
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We manufacture over 200 different Gold Bonded Diodes with inverse current capabilities for 5 to 250 volts. All of our diodes meet the requirements of MIL-S-19500. For more information or samples, write or call BKC.

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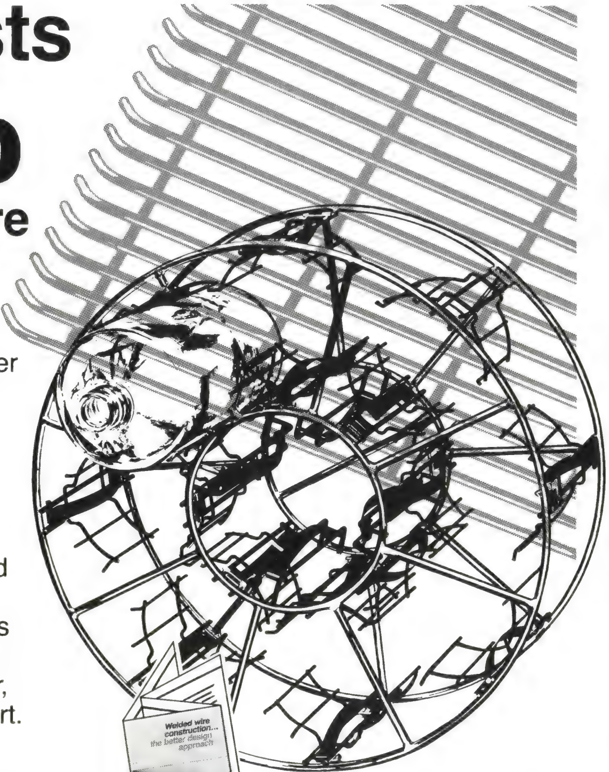
CIRCLE NO 6

Cut Costs 50% with steel wire construction



Fortune 500 companies and thousands of smaller companies use Titchener steel wire construction in their products. They chose welded wire construction to replace sheet metal, plastic, or castings because welded wire produces a better product and typically cuts cost as much as 50%. It also produces a stronger, lighter, better working part.

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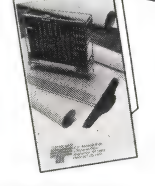

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Send today for our new engineering guide. It's loaded with good design ideas and it's free.

CALENDAR

90231. (800) 421-8166; in CA, (213) 417-8888. December 1 to 4.

Troubleshooting Microprocessor-Based Equipment and Digital Devices, Oklahoma City, OK. Micro Systems Institute, 73 Institute Rd, Garnett, KS 66032. (800) 247-5239; in KS, (913) 898-4695. December 1 to 4.

IEEE International Electron Device Meeting (IEDM), Washington, DC. Courtesy Associates, 655 15th St NW, Suite 300, Washington, DC 20005. (202) 347-5900. December 6 to 9.

Lasers '87, Lake Tahoe, NV. Society for Optical and Quantum Electronics, Box 245, McLean, VA 22101. (703) 642-5835. December 7 to 11.

Hands-On Graphics Programming Using GKS/VDI Tools, Los Angeles, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. December 8 to 11.

Microcomputer Graphics Conference, New York, NY. Expoconsul International, 3 Independence Way, Princeton, NJ 08540. (609) 987-9400. December 16 to 18.

CIRCLE NO 7

Need <1 ns speed?

Get it with our
new silicon-gate
DMOS FETs and
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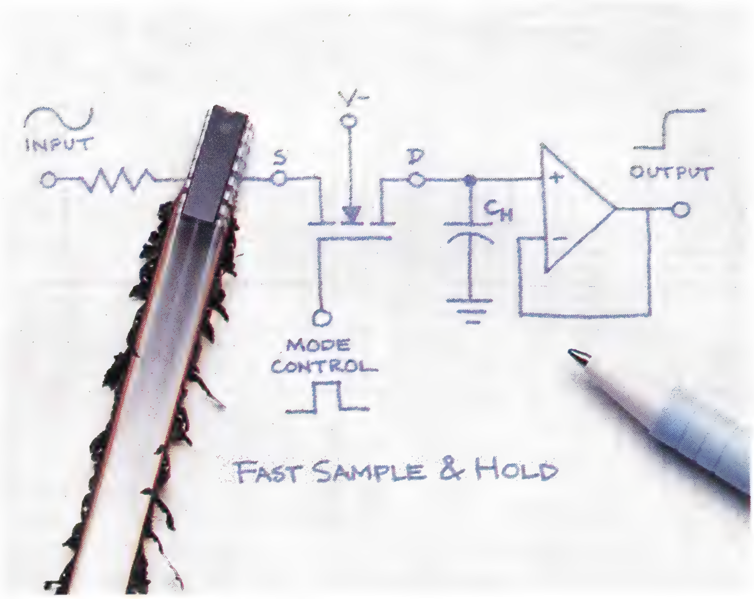
Greater accuracy.
Lower capacitance.
Higher gain.
And less distortion.



Sometimes you can't get the switching speed your designs need from CMOS, JFET or bipolar technologies. And it's not often you require the expensive performance of gallium arsenide.

Get the accuracy you require with fast switching, low capacitance Siliconix SD210/2N7104 FETs and SD5000/2N7116 analog switches. They're available now! Fabricated in silicon-gate DMOS — the most stable technology for analog switches, multiplexers, A/D and D/A converters, choppers and sample-and-hold circuits that operate into the 750 MHz range.

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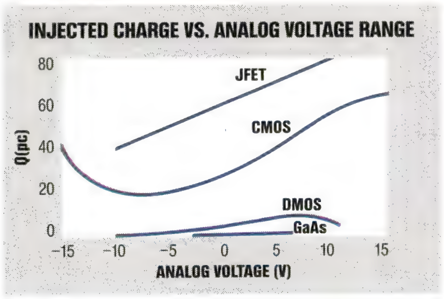

Circuit accuracy is a function of charge injection. The DMOS process significantly outperforms CMOS, JFET and bipolar in this critical parameter.

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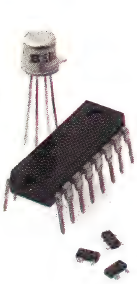

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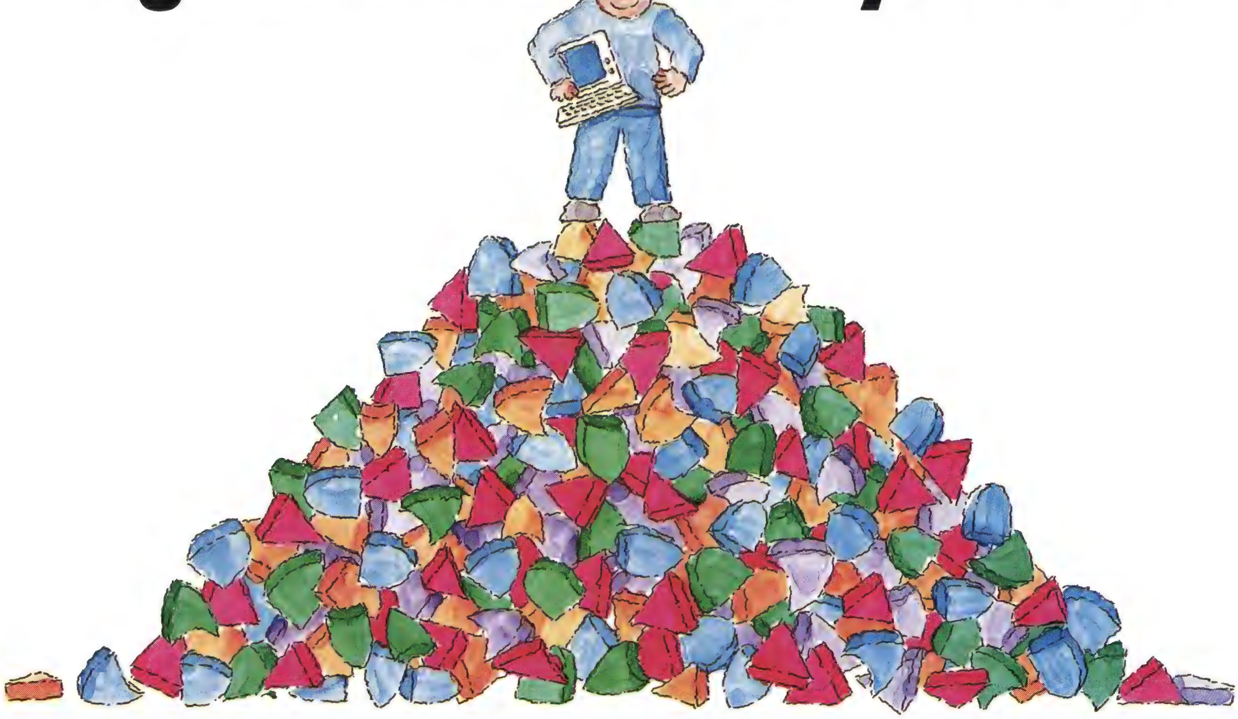
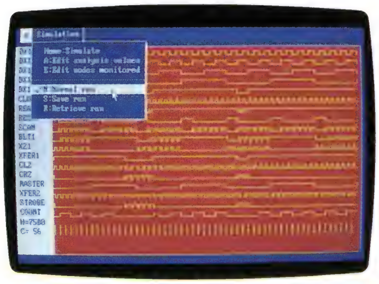
MICRO-LOGIC II.™ The CAE tool with a 10,000-gate digital simulator for your PC.



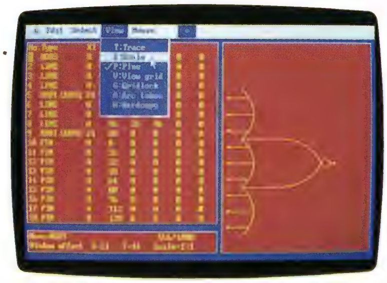
Spectrum Software's MICRO-LOGIC II® puts you on top of the most complex logic design problems. With a powerful total capacity of 10,000 gates, MICRO-LOGIC II helps engineers tackle tough design and simulation problems right at their PCs.

MICRO-LOGIC II, which is based on our original MICRO-LOGIC software, is a field-proven, second-generation program. It has a high-speed event-driven simulator which is significantly faster than the earlier version.



Timing Simulator

The program provides you with a top-notch interactive drawing and analysis environment. You can create logic diagrams of up to 64 pages with ease. The software features a sophisticated schematic editor with pan and zoom capabilities.



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A 200-type library of standard parts is at your fingertips. And for a new high in flexibility, a built-in shape editor lets you create unique or custom shapes.

MICRO-LOGIC II is available for the IBM® PC. It is CGA, EGA, and Hercules® compatible and costs only $895 complete. An evaluation version is available for $100. Call or write today for our free brochure and demo disk. We'd like to put you in touch with a top digital solution.

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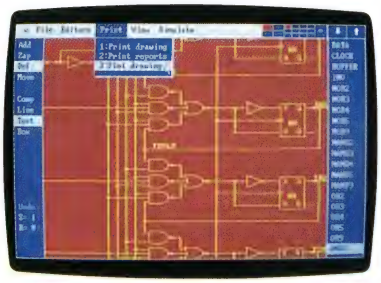

Schematic Editor

spectrum

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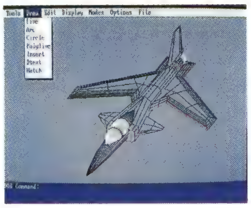
CIRCLE NO 185

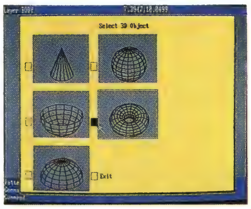
AUTOCAD® RELEASE 9. ITS ENHANCEMENTS ARE EVIDENT.

AutoCAD's new release builds on the strengths of its eight predecessors. Here's how:



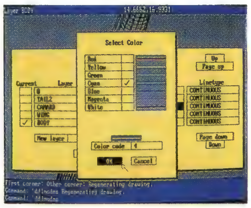
PULL-DOWN MENUS.

Release 9's pull-down menus let you choose all of AutoCAD's fundamental commands with a click of your mouse or digitizer. You can also customize menus to provide your own frequently used commands. Pull-down menus are compatible with AutoCAD's proven system of screen and tablet menus.



ICON MENUS.

When you wish to select 3-D objects, text fonts, or hatch patterns, for example, you can pick them from an icon menu that appears on the screen. You can do the same thing with objects you create on your own. Icon menus make it easier and faster to choose the option you want.



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These let you converse with AutoCAD; give it instructions by "filling in the blanks." They can simplify many of your tasks—entering layer information, for example.

FILE PORTABILITY.

With Release 9, drawing files are directly compatible without any conversion steps across four different operating systems on four different machine architectures: PC-DOS/MS-DOS, Apollo AEGIS, DEC VMS, Sun UNIX.*

On a network with different types of computers you can access a single copy of a drawing from any machine.

MORE NEW FEATURES.

Release 9 also offers you twenty additional text fonts from the industry standard Hershey library, B-spline curve generation, and a direct link to the newly released AutoShade.™

RELEASE 9 = MORE POWER + EASIER ACCESS.

If you think CAD would boost your productivity, but you worry that a serious professional CAD package will take forever to learn, AutoCAD Release 9 is for you.

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Your dealer will also show you which graphics systems can support our new display capabilities.

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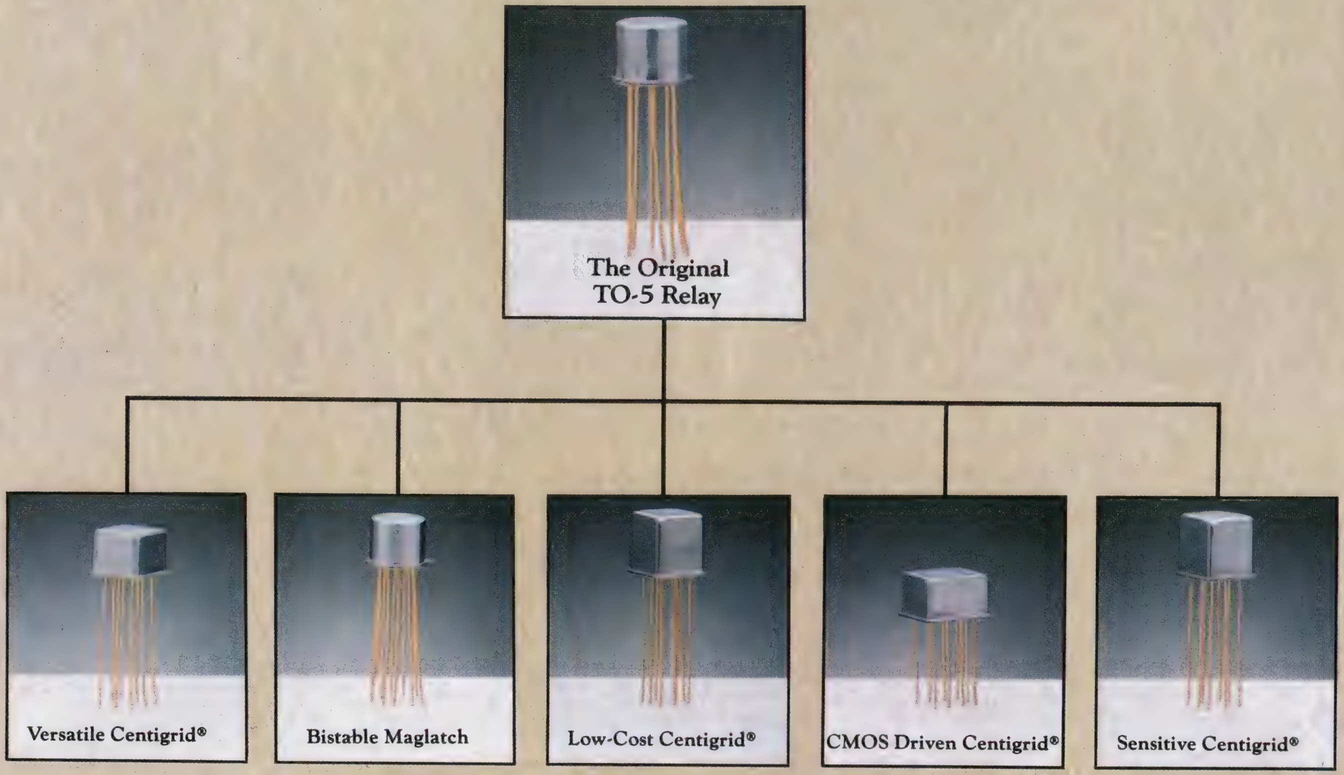
Tools for the golden age of engineering.

CIRCLE NO 184

From the industry's first choice come the industry's first choices.



We designed the original TO-5 relay over 20 years ago. But that was just the beginning. Since those first days, we nudged it into fathering a family of adaptations and extensions along the way.

In the process we also pioneered many innovative techniques for production, for manufacturing, and for quality control to ensure a reliability level so consistently high it would be taken for granted.

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Soon, TO-5 relays were available in latching versions, in single, double and 4-pole styles, and in hybrid versions with internal diode and transistor drive. All with excellent RF switching characteristics.

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Our family boasts the Centigrid,® possibly the most advanced hermetically sealed armature relay available today. The Maglatch, a relay with memory and low power requirements. And lots of brothers and sisters to handle applications like high temperature, high shock, and high vibration designs for critical, hi-rel applications. We even have versions that can be driven directly from CMOS and TTL (qualified to "L" and "M" levels of MIL-R-28776).

If you'd like complete technical information on our TO-5 relay and all its offspring, or some applications help, or just a little history, drop a note or give us a call.

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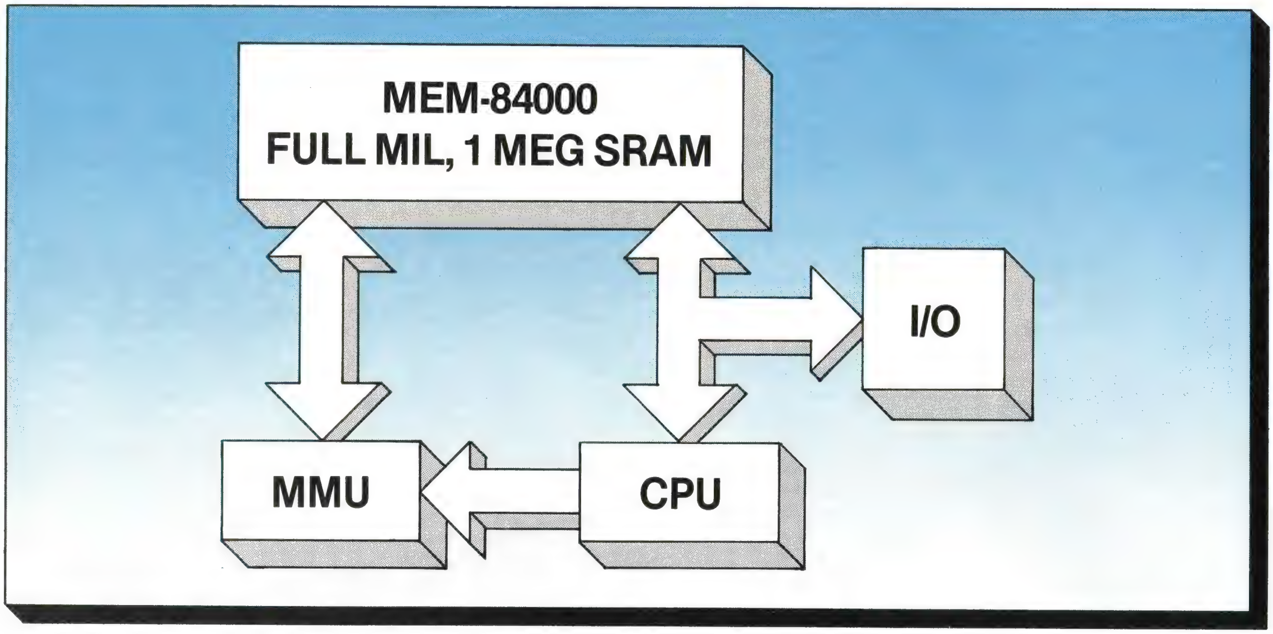

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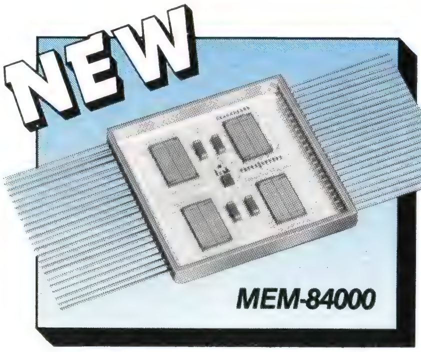

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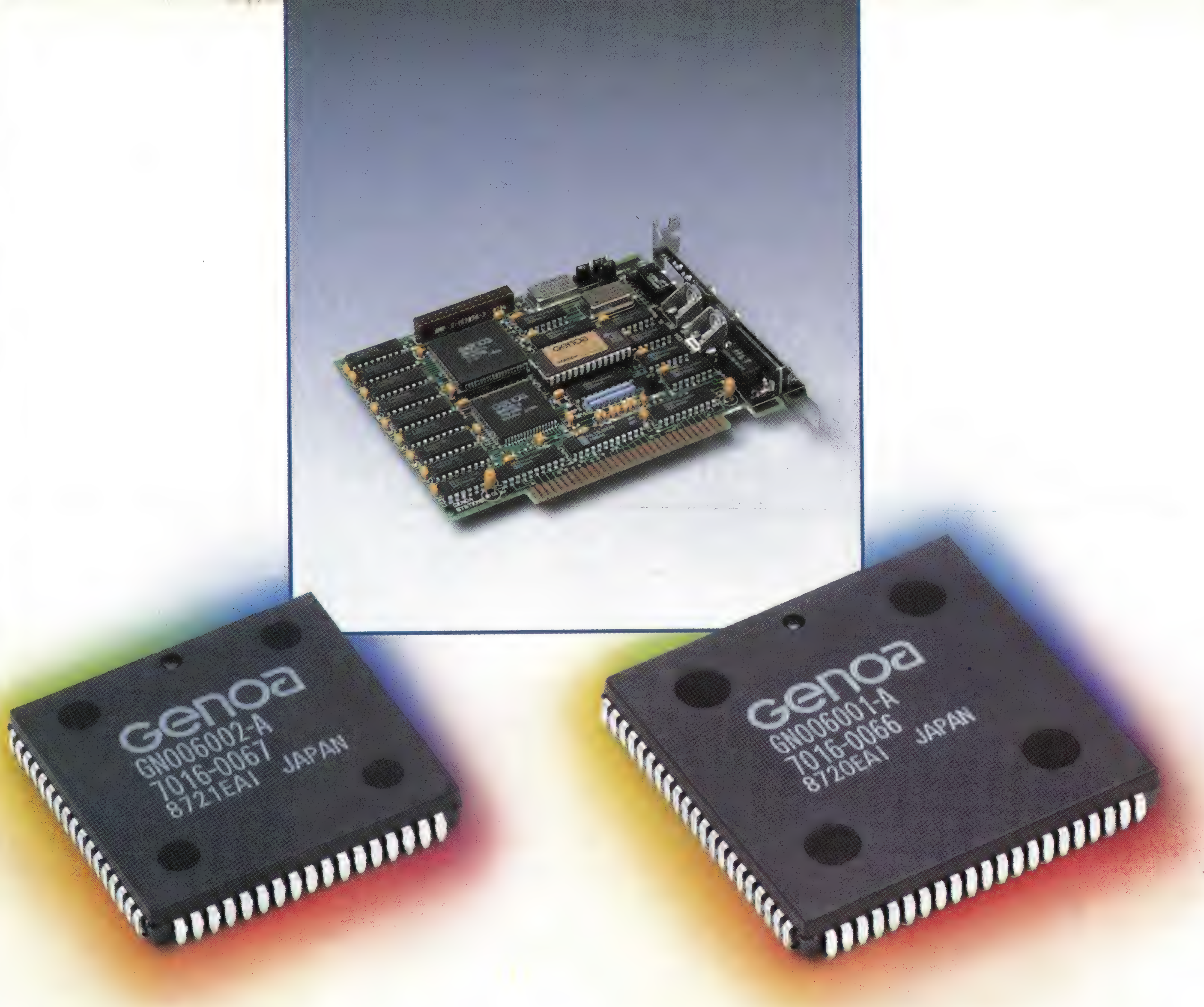

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EDITORIAL

DAT's the way it is

Washington, DC, October 1, 1990*—The House Subcommittee on Commerce, Consumer Protection, and Competitiveness voted today to ban digital backup cassette tapes and floppy disks. "By adding such devices to the 1987 Digital Audio Recorder Act, the committee has taken an important step toward preserving intellectual-property rights," stated a committee spokesman. "People are abusing these devices, copying and distributing computer programs at will. Programmers deserve protection," he added.*

Although the scene above is fanciful, such action isn't out of line with Congress's current mood. In fact, Congress may act soon—if it hasn't already—to ban digital audio tape (DAT) recorders. Supporters of the 1987 Digital Audio Recorder Act argue that such a measure is necessary to prevent unauthorized copying of compact-disk (CD) recordings. Under the terms of the pending bill, DAT recorders couldn't be sold during the next year unless they included a copy-prevention circuit that would make it impossible to accurately reproduce CD-quality sound on a DAT.

It's difficult to ban or restrict technology. When audio cassettes became available, there were similar arguments about illegal copying of long-playing records. Likewise, when VCRs became readily available, there were futile attempts to regulate the industry. Luckily, reason and the consumer prevailed. Support for prohibitions waned as movie and record companies saw new markets for their products. These days, few people go to the trouble of recording music when it's available on an inexpensive tape.

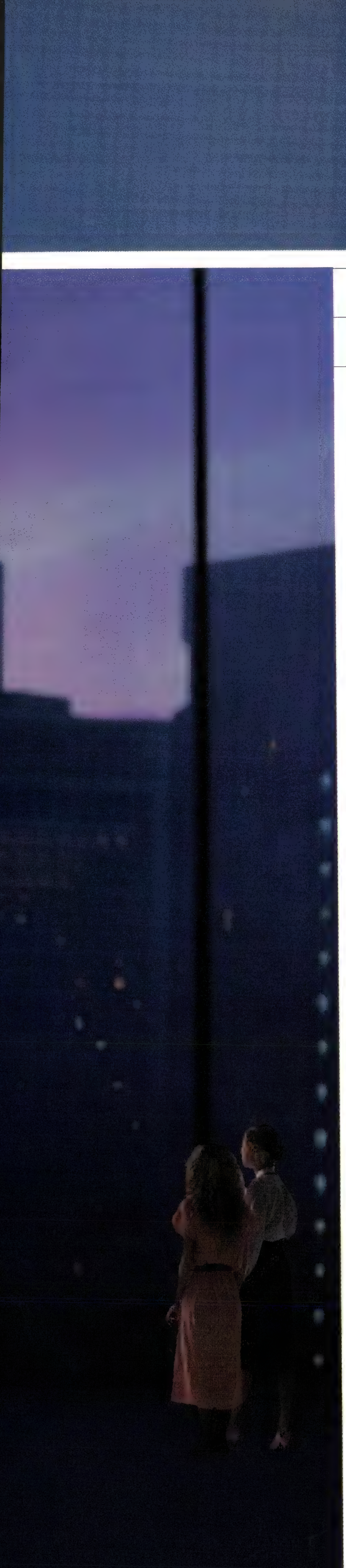
Just suppose that someone had proposed a ban on floppy disks in the early 70s. Proponents of such a ban could have argued that floppy disks would let people quickly copy and bootleg programs that were previously available on large rolls of punched paper tape or on punched cards. But because there was no mass market for such media and no powerful computer companies or lobbyists were involved, technology carried the day. In fact, the availability of inexpensive disks helped spawn the personal-computer industry.

Rather than banning DAT recorders, the congressional committee should concentrate on commerce, consumer protection, and competitiveness. Technology will take care of itself in the marketplace. Who knows? The DAT technology, too, might spawn a new industry.

Jon Titus

Jon Titus
Editor

Your window of opportunity



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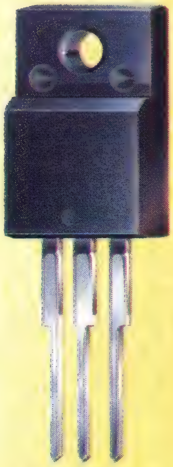

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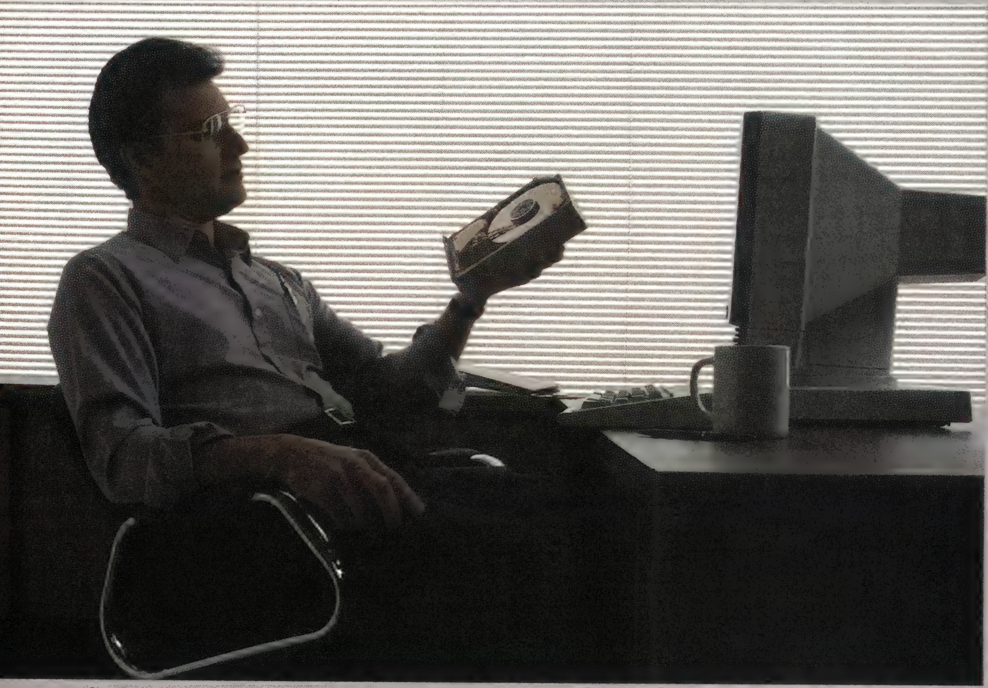

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Low-cost digital ICs provide flexibility for applications requiring voice output

John Gallant, *Associate Editor*

Myriad applications are driving the development of low-cost digital ICs for artificial-voice synthesis, and these ICs are offering designers considerable flexibility. You can use the chips to tailor synthetic spoken messages for applications ranging from the practical (telephone message systems, automotive diagnostics, personal-computer interfacing, and aids for the handicapped) to the whimsical ("synthetic companions," such as talking dolls).

Traditionally, magnetic recording has supplied an inexpensive, easy approach for implementing voice-output capability, but that approach lacks flexibility: It won't let you create "boilerplate" messages. Consider, for example, the message "Deposit 'N' cents, please," where N is a variable. Magnetic tape doesn't allow easy substitution of a different N each time the message repeats, but digital ICs do.

Three synthesis techniques

Voice-synthesis methods divide into three major types:

- Waveform encoding
- Parametric synthesis
- Synthesis by rule.

The first two of these methods require, as the first step toward synthesis, the analysis of a recording of human speech that contains the words or phrases to be synthesized. Synthesis by rule doesn't require such an analysis step, and therefore, the vocabulary of a system employing synthesis by rule isn't limited to the words in an analysis system's recorded-message library. But of the three techniques, synthesis by rule generally yields the lowest quality speech output.

Consider, first, the waveform encoding method. It entails sampling and digitizing a speech waveform by using a fixed-interval form of pulse-code modulation (PCM) and then reducing the amount of data with code-compression techniques. One such technique is Adaptive Differential Pulse Code Modulation (ADPCM), which reduces the PCM bit rate without severe degradation of the S/N ratio of the resulting synthesized speech.

The bit rate for PCM-encoded data depends on the sample rate and the quantization width. For example, good quality speech requires a 12-bit A/D converter sampling at 8

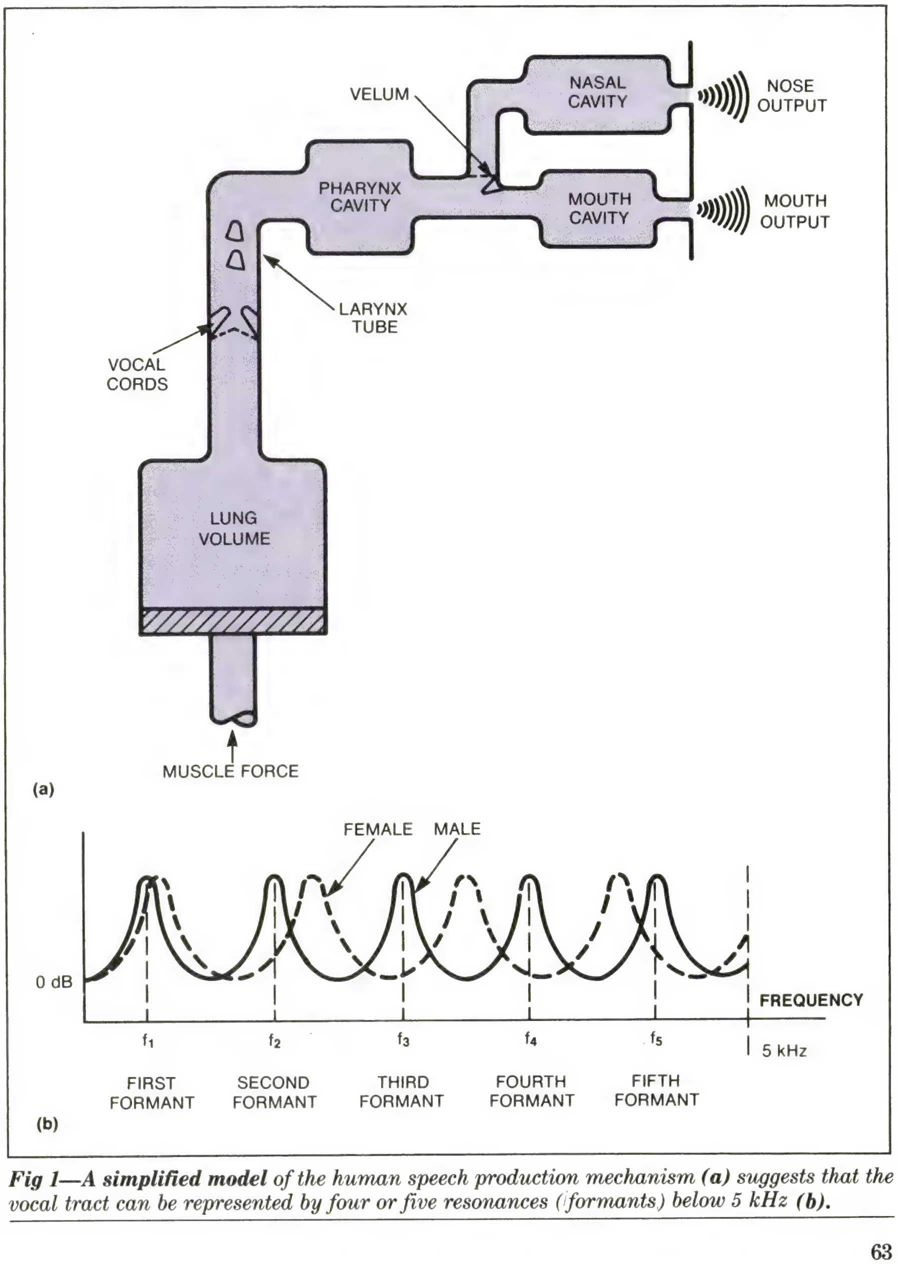

Fig 1—A simplified model *of the human speech production mechanism* ***(a)*** *suggests that the vocal tract can be represented by four or five resonances (formants) below 5 kHz* ***(b).***

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kHz, resulting in a 96k-bps rate. ADPCM reduces the amount of data by quantizing and encoding the differential between adjacent samples. Adaptive changes to the quantization width depend on the amount of the differential. When the differential is large, the quantization width increases. When the differential is small, the quantization is reduced.

The MSM6258 speech processor from Oki Semiconductor contains a speech-analysis stage in which PCM data is compressed to 3- or 4-bit ADPCM data. The chip's compressed ADPCM mode makes further data reduction possible, at the expense of quality. Compressed ADPCM eliminates intervals of silence that exceed a certain time length, and it eliminates redundancies in, for example, the waveforms that represent vowels. The bit rate in the compressed ADPCM mode can be reduced by as much as one-third of the ADPCM bit rate, depending on the characteristics of the speech.

The MSM6258 contains an 8-bit A/D converter, which samples analog speech at a 4.0-, 5.3-, or 8.0-kHz rate when the on-chip clock uses 4.096-MHz crystal. The chip also has a provision to accept PCM encoded data from an external 8- to 12-bit A/D converter. Using a 12-bit ADC and selecting a 4-bit ADPCM yields 16k-, 21.2k-, and 32k-bps data rates at the 4.0-, 5.3-, and 8.0-kHz respective sampling rates. Lower bit rates are possible using the compressed ADPCM mode and 3-bit quantization.

The chip can obtain ADPCM-encoded data from as much as 1M bits of external dynamic RAM or from as much as 256k bits of external static RAM. The chip contains an internal dynamic-RAM controller with refresh circuitry. Playback is also possible from EPROMs. On playback, PCM data is reconstructed using an on-chip DAC with 10-bit quantization level.

The chip comes in two versions: one for stand-alone operation (over the −40 to +85°C temperature range) and one (which operates from −30 to +70°C) for interfacing with an 8-bit μP. Four plastic-package options include a 40-pin DIP, 44- and 60-lead flat packages, and a 68-lead chip carrier. Each chip requires a 5V supply with current draw of 4 mA max. In standby mode, the chip draws 10 μA when used with static RAMs. Each chip costs $12.90 (1000).

Oki also produces two digital ICs, the MSM6308 and the MSM6309, that combine speech-synthesis and -analysis capability. For analysis, they contain on-chip amplifiers and lowpass filters, which permit direct connection to a microphone. Each chip contains a built-in 8-bit A/D converter and an 8-bit DAC as well as a speaker-driving amplifier. They both use the ADPCM algorithm for speech analysis and synthesis, with selectable sampling frequencies of 4 and 8 kHz. The MSM6308 stores speech data in 256k bits of external dynamic RAM, and the MSM6309 uses 256k bits of external static RAM. The MSM6808 comes in a 44-pin plastic flat package; the MS6809 comes in a 60-pin plastic flat package. Both devices require a 5V supply and operate from −40 to +85°C. Each chip costs $5.50 (1000).

Toshiba America also features waveform coding as a method of voice synthesis. The company has several digital ICs that use an Adaptive Delta Modulation algorithm for code compression. The algorithm is a variant of ADPCM.

Parametric synthesis

Parametric synthesis is a method of speech synthesis that can achieve a higher degree of data compression than does waveform encoding, but the higher compression does result in a somewhat lower quality. Nevertheless, the quality is more than adequate for many applications, and Texas Instruments, a parametric-synthesis proponent, offers a tape recording that allows you to judge for yourself the effects of various levels of compression.

The key to parametric synthesis is a model of the human speech production mechanism **(Fig 1a)**. The vocal tract is excited when the air from the lungs is forced through the vocal chords (two small flaps at the base of the larynx). When voiced sounds such as "A" or "E" are produced, the vocal chords vibrate to modulate the air from the lungs,

For more information...

For more information on the digital ICs or services discussed in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

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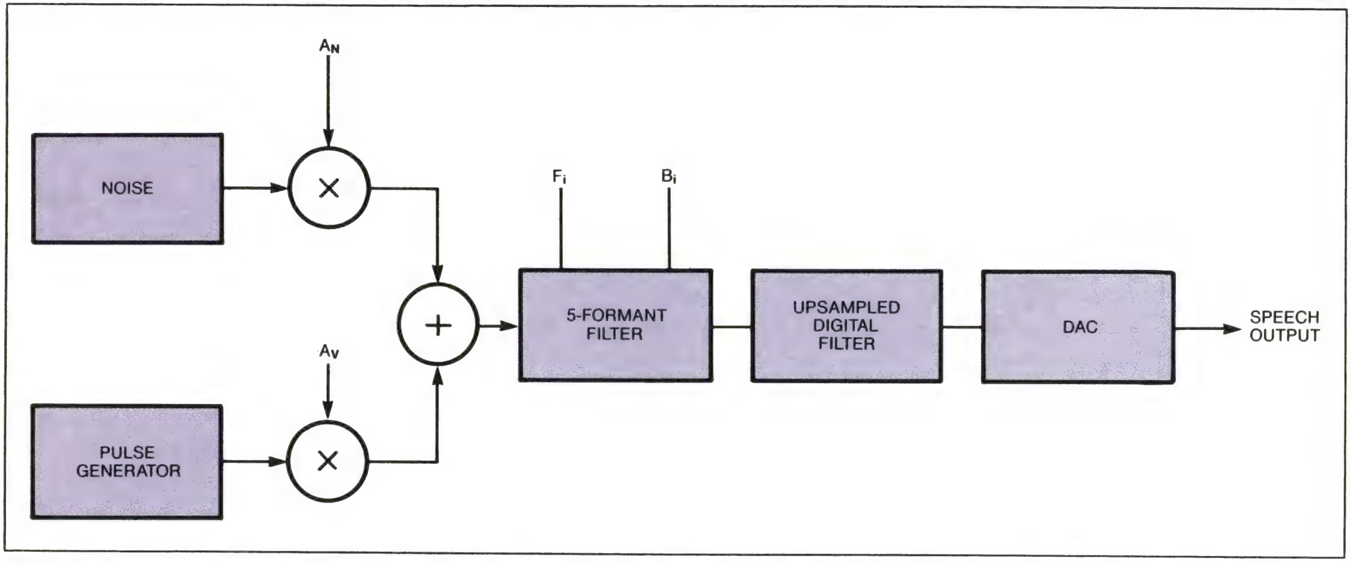

***Fig 2—An electronic speech model** requires the combination of amplitude-modulated noise and pulse sources that excite a filter that simulates five formants.*

thus producing pulses of air that are nearly periodic. The period determines the pitch of the sound produced. Besides the voiced sounds, unvoiced—or noise—sounds, such as "S," are required to generate speech. Unvoiced sounds are produced when turbulent air passes through the open vocal tract.

Situated above the vocal chords are the pharynx and the oral and nasal cavities, all of which shape the spectrum of the sound. The vocal tract can be thought of as an acoustic tube that's nearly closed at the vocal-chord end and open at the other. The frequency response of such a tube with constant diameter is characterized by a number of resonances known as formants (**Fig 1b**).

In parametric synthesis, an analysis system extracts parameters from recorded speech and stores them in ROM. A synthesis chip then uses that data to electronically and dynamically model the vocal tract.

One such chip is the Signetics PCF8200, a 24-pin CMOS device that operates from −40 to +85°C. The $15 chip operates from one 5V supply with a typical current draw of 10 mA; it can be switched to a standby mode, in which it draws 200 μA typ. The synthesizer is divided into three sections: a μC interface and control section; a formant synthesizer; and an output stage.

Fig 2 shows a simplified electronic model of the human speech production mechanism that's used by the PCF8200. Here, a periodic source and a noise source, respectively, represent the voiced and unvoiced sounds. The outputs of these sources are amplitude-modulated, combined, and fed to the formant filter, which mimics the vocal tract.

To create the parameter data needed to make the PCF8200 speech synthesizer talk, a recording of the speech to be synthesized must be analyzed using a $5500 Signetics OM8210 speech-development system. This system is a hardware input/output adapter box for either the Hewlett-Packard 9816S or the IBM PC/XT computers. All software for analyzing, coding, and editing speech resides on a floppy disk. The system features a graphic display of the speech parameters, allowing synthesized speech segments or single frames to be pronounced and checked for quality during interactive editing.

Although Signetics performs speech analysis for high-volume customers, it recommends that most speech development be done by outside speech-coding services. One of these services, Voice-Tech, accepts a vocabulary list or a list of complete sentences; the company develops the synthesized speech code files and stores them in EPROMs. Cost for this service is nominally $70 for new words and $50 for canned words.

The analysis process divides recorded speech into intervals called frames and then determines for each frame a set of parameters that describes the speech. In the synthesis step, the PCF8200 synthesizer chip accesses the EPROM-resident frame parameters via a μP that uses the I²C serial bus or an 8-bit parallel bus. Standard frame durations of 8.8, 10.4, 12.8, or 17.6 msec are software selectable.

The PCF8200's on-chip 8-step linear interpolator smoothes the transition from one set of parameters to the next. A frame whose parameters can be approximated by interpolation between parameters of adjacent frames need not be encoded, thereby saving memory.

To model the formants, the PCF8200 uses a vocal formant synthesis algorithm that's a variation of a linear-predictive-coding technique. The excitation signal is filtered with a 5-formant filter for male speech and a 4-formant filter for female speech. The formant filter is a cascade of second-order sections. The control parameters, formant frequencies, and bandwidths are updated eight times per speech

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frame by linear interpolation.

The formant-filter output is eight-times oversampled (or upsampled) to reduce quantization noise, and it's applied to a digital lowpass filter, whose output is then scaled up or down for optimum positioning for an on-chip 11-bit DAC. The digital filter reduces the requirement for external filtering before application of the synthesis chip's output to an amplifier and speaker.

Linear predictive coding

Texas Instruments also manufactures speech devices that perform parametric synthesis. The TI parts use a pitch-excited linear-predictive-coding (LPC) technique. The TSP5220C uses an LPC-10 (linear-predictive coding with a tenth-order filter) voice-synthesis function. It's a 28-pin device that operates from 0 to 70°C and requires −5V and 5V power supplies, from which it draws 10 mA and 3 mA, respectively.

The chip's microcontroller interface consists of an 8-bit bidirectional bus with read, write, interrupt, and ready control signals. Data is written into a command register or a 128-bit FIFO register. A data register and a status register send data to the host µP. For added flexibility, the TSP5220C's 4-bit address bus provides a direct interface to the external TSP6100 Series vocabulary ROM. Synthesized-speech data outputs are provided in an analog and a digital format. An on-chip 8-bit DAC, which operates at 8 kHz, provides the analog output. The chip operates at data rates from 1000 to 1700 bps. An external lowpass filter, amplifier, and speaker are required to produce sound. The chip sells for $9.20 (100).

The TSP50C41/42/40A chips from TI also implement an LPC-10 speech-synthesis algorithm, but they each have an internal processor that can access speech data from an internal or an external ROM; they therefore suit high-volume applications. The µP is an 8-bit processor with 8k bytes of ROM. The housekeeping code required for speech synthesis and interface to a host µP is typically 1k to 2k bytes, leaving 6k to 7k bytes of internal ROM for speech data. The chips have an 8- and a 4-bit µP interface.

Speech data rates vary from 800 to 2000 bps, depending on quality. During speech synthesis, data is retrieved, decoded, and sent to the on-chip LPC-10 lattice filter. The input to the lattice filter is an exitation source that uses data stored in an on-chip excitation ROM to furnish either periodic (for voiced sounds) or pseudorandom (for unvoiced sounds). Pitch is stored in a dedicated register that accesses the excitation ROM. Interpolation of data between frames is accomplished by a ROM-resident speech algorithm.

The lattice-filter output is sent to an on-chip DAC. The chips operate from 0 to 70°C and require one 5V supply. The TSP50C41 comes in a 28-pin package and features a 128-bit RAM, a 150-mW drive capability into a 50Ω speaker, and two 8-bit I/O ports. The TSP50C42 has the same features with two additional 8-bit I/O ports in a 40-pin package. The TSP50C40A is a 28-pin device with reduced features. Prices for the chips start at $5 (OEM qty).

TI provides a speech-development service (called SDS), for which it charges $100/word to store speech parameters in EPROM for use with the TSP220C. Because the TSP50C41/42/40A requires an internal ROM to be programmed, speech development is only available for minimum orders of 10,000 units/year. TI has indicated that a personal-computer version of SDS will be available in early 1988.

TI is also finding uses for the TMS320C17 digital-signal-processing (DSP) chip in parametric speech science. The parametric devices thus far discussed require non real-time speech analyses by minicomputer systems. A block diagram of a speech system that can perform parametric speech synthesis as well as real-time speech analysis and speaker verification is shown in **Fig 3.** It consists of a host µP, a DSP chip, a codec (TCM29C18), and a speech-data ROM. The codec consists of an input antialiasing filter and a nonlinear (µ-Law or A-Law) A/D converter, which allows speech to be sent to the DSP chip and to a DAC and filter for speech output.

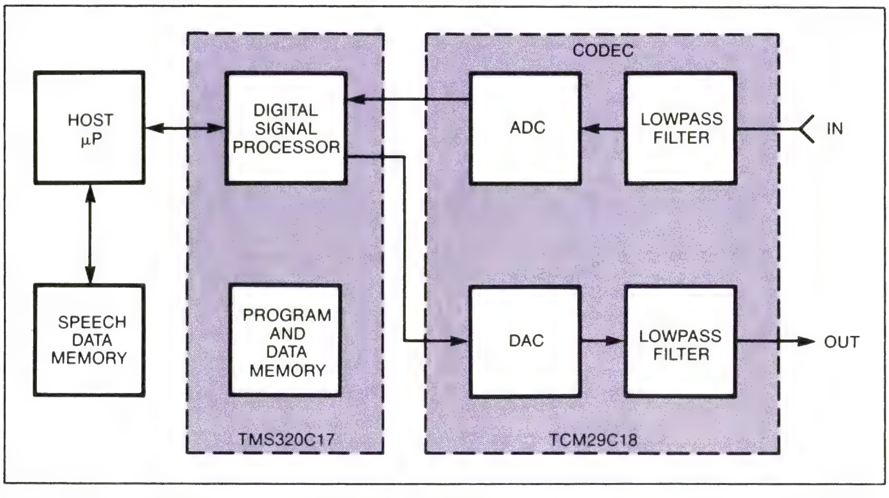

Fig 3—A real-time speech-synthesis I/O system *using a DSP IC and a codec eliminates the need for voice-parameter analysis by computer.*

Several speech algorithms have been developed to run on the TMS320C17/codec hardware. These algorithms include ADPCM coding, LPC synthesis, speech recognition, and dual-tone multiple frequency (DTMF) encoding and decoding for telecommunications. The TMS320C17 and the TCM29C18 cost less than $10 (OEM qty), and

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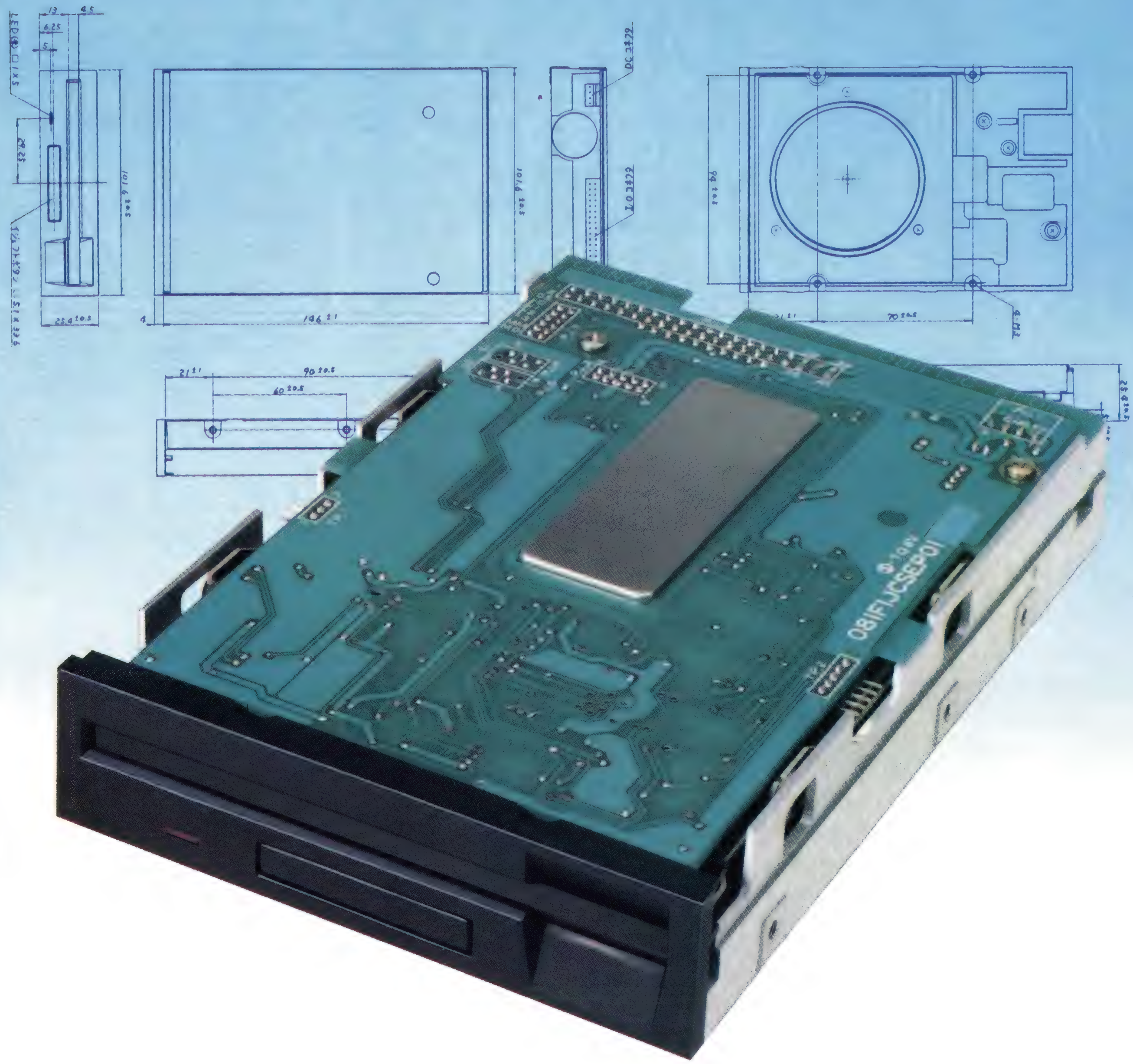

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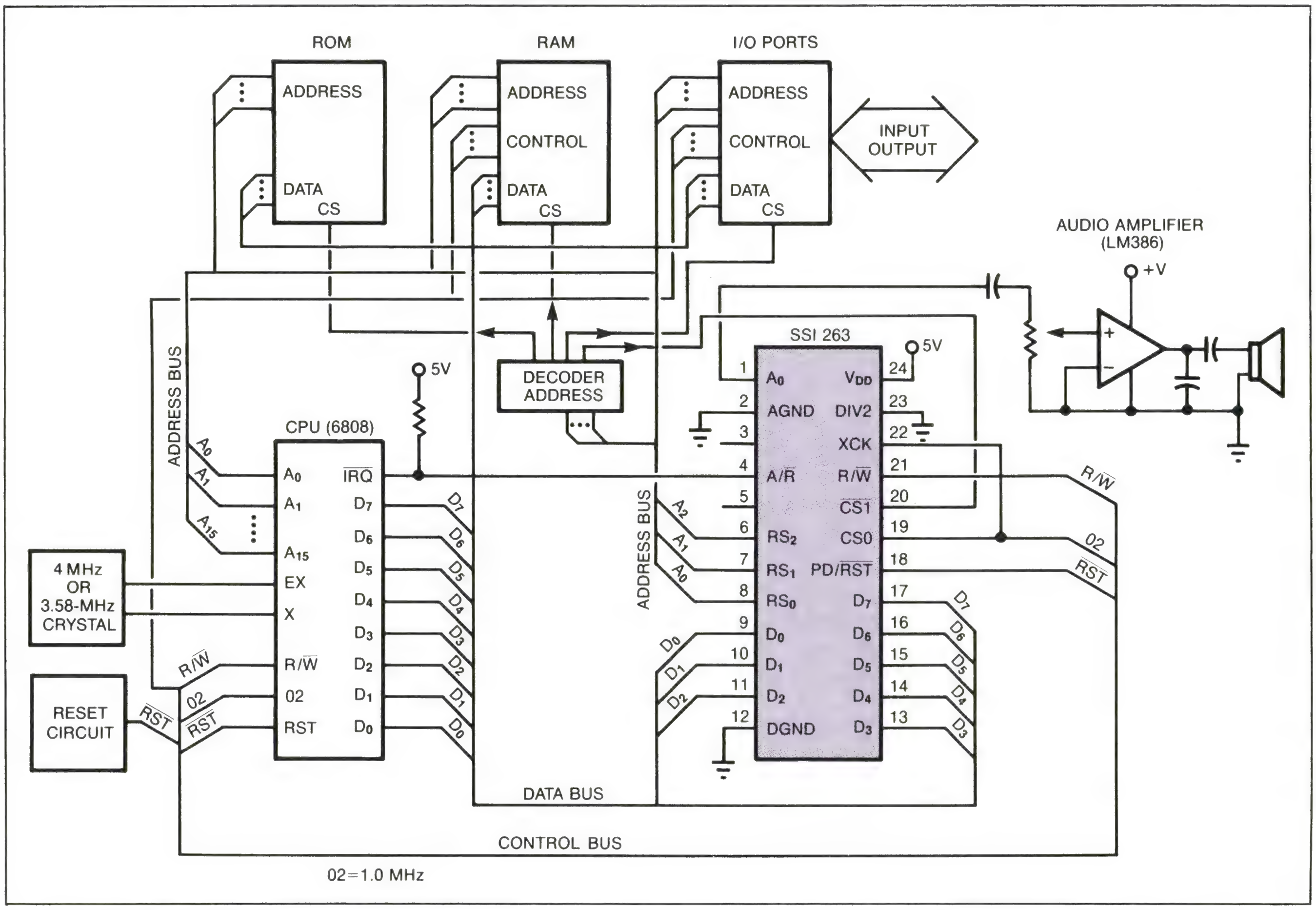

*Fig 4—**An unlimited-vocabulary** speech system is possible when an IC containing phoneme synthesis is combined with a μP.*

the software is available from TI in application notes.

An application of this speech-synthesis approach appears in a toy by Worlds of Wonder called Julie. The doll is able to make 100 sound-activated intelligent responses with a 64k-word resident memory. Through a conversation training process, it can store as much as three minutes of synthesized speech.

Synthesis by rule

The previously discussed speech-synthesis methods require priming by a human voice to obtain speech data. However, every language contains a number of basic speech sounds (phonemes) that represent the building blocks of speech. English, for example, contains 50 or so distinct sounds. Speech synthesis by rule is accomplished by storing these basic units in memory and combining them in a proper sequence to develop speech. Although this technique produces a more primitive quality of speech, it has the advantage of an unlimited vocabulary.

The SSI 263A phoneme speech synthesizer from Silicon Systems stores 64 phonemes or allophones (an allophone is one of two or more variants of the same phoneme) in ROM. Speech is produced when successive phonemes are accessed and sent to a model of the human vocal tract. The vocal tract is modeled in the chip by five cascaded programmable filter sections using switched-capacitor filters. Either a glottal (pitch) or a pseudorandom noise source is used to excite the vocal tract model, depending on whether a voiced or nonvoiced phoneme is selected; **Fig 4** shows a typical μP-controlled implementation.

Attributes such as speech rate, pitch, amplitude, vocal-tract filter frequencies, phoneme articulation rate, phoneme duration, and inflection are stored in attribute registers. Speech data rates depend on the amount of speech attribute manipulation and can range from 100 to 500 bps. During speech production, phonemes typically last between 25 and 100 msec. The 24-pin CMOS chip operates over −40 to +85°C and draws 20 mA max from a 5V supply. The chip sells for $18.90 (100).

General Instrument also manufactures speech-synthesis products that will perform speech synthesis by rule. The $2 (OEM qty) SP0264 is a 28-pin device with an internal 64k-byte (8k×8-bit) ROM that can be programmed to support LPC synthesis and formant synthesis as well as allophone synthesis. **EDN**

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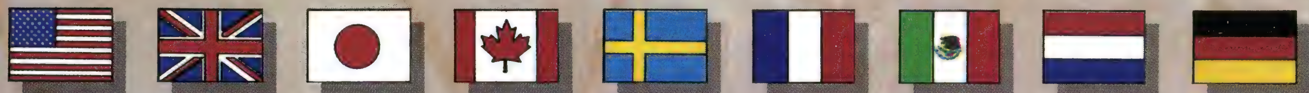

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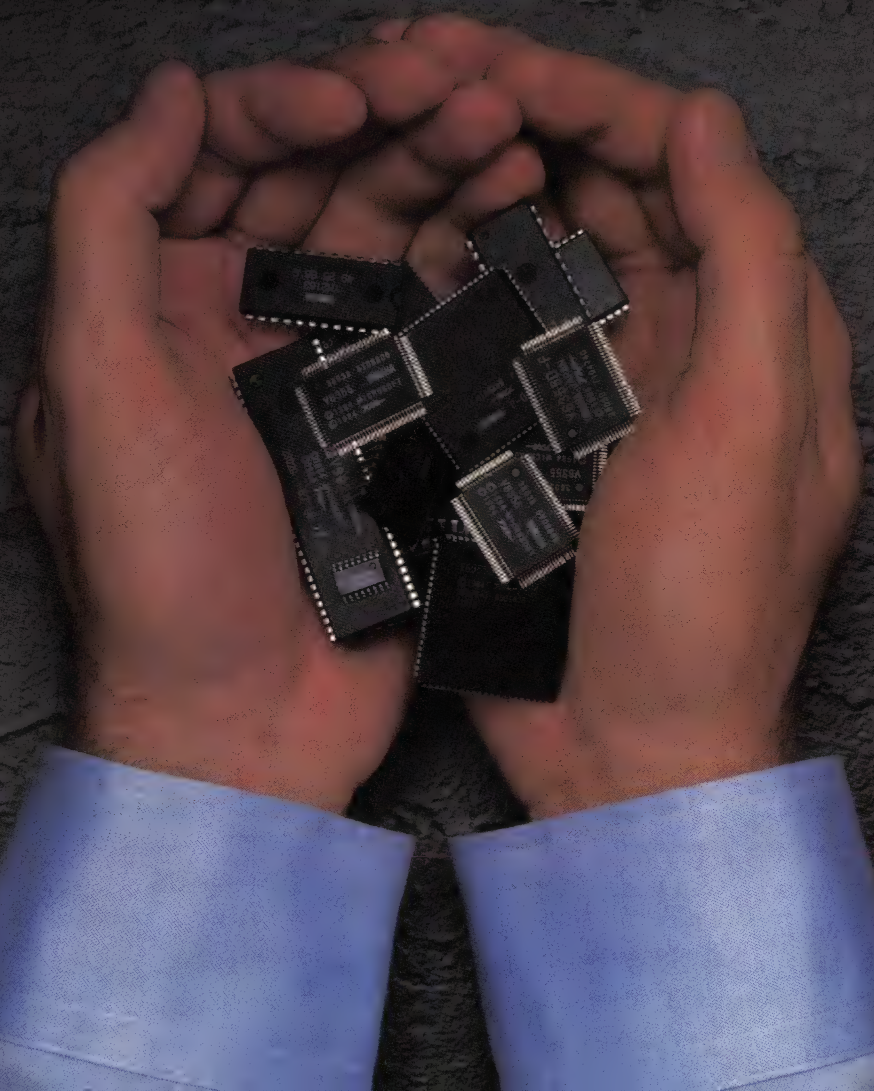

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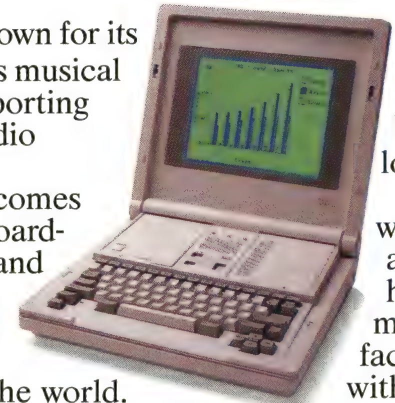

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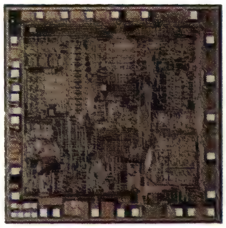

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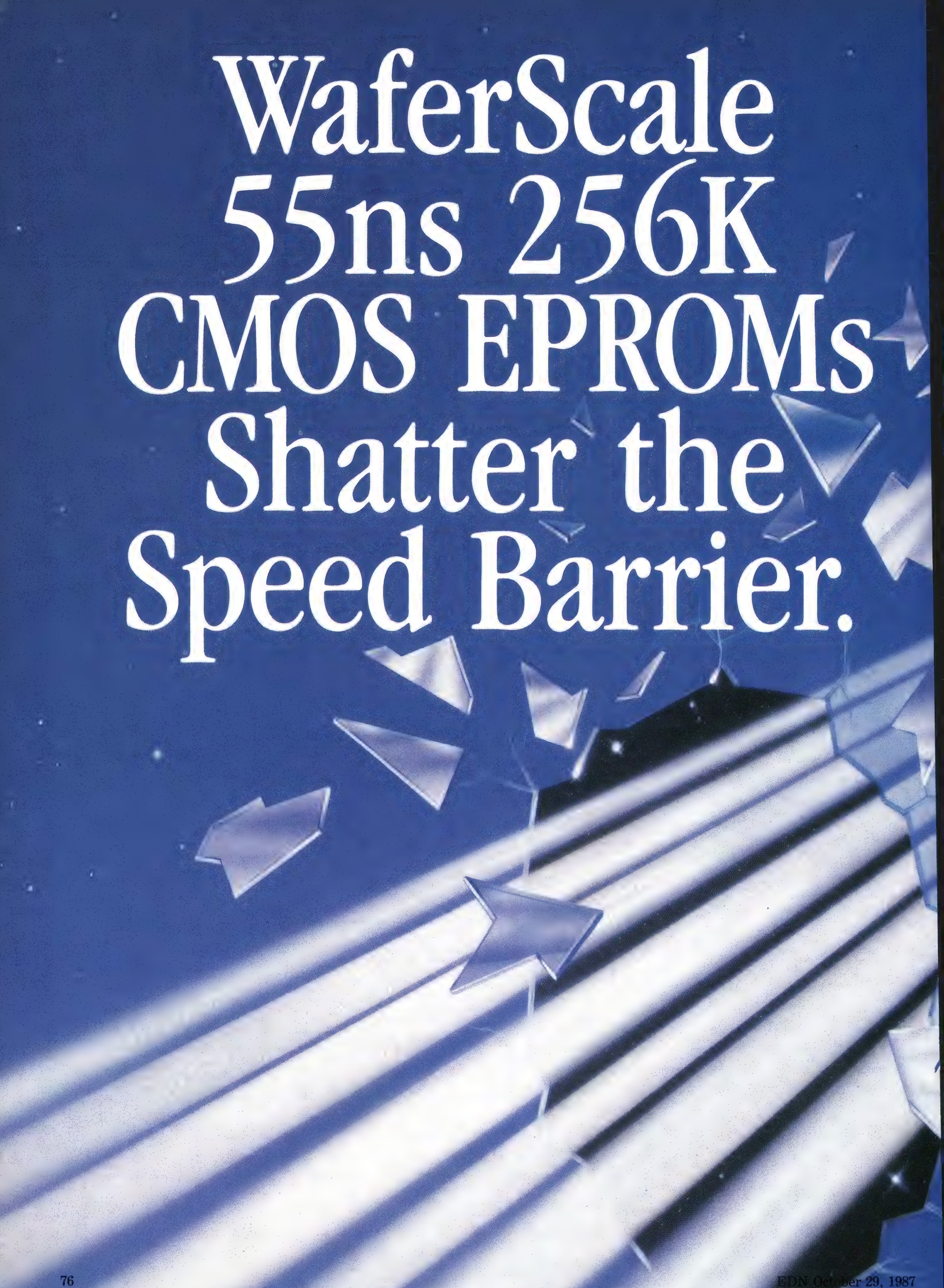
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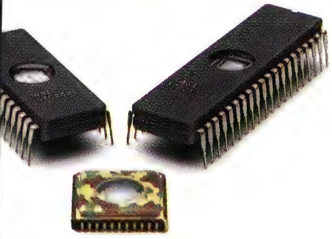

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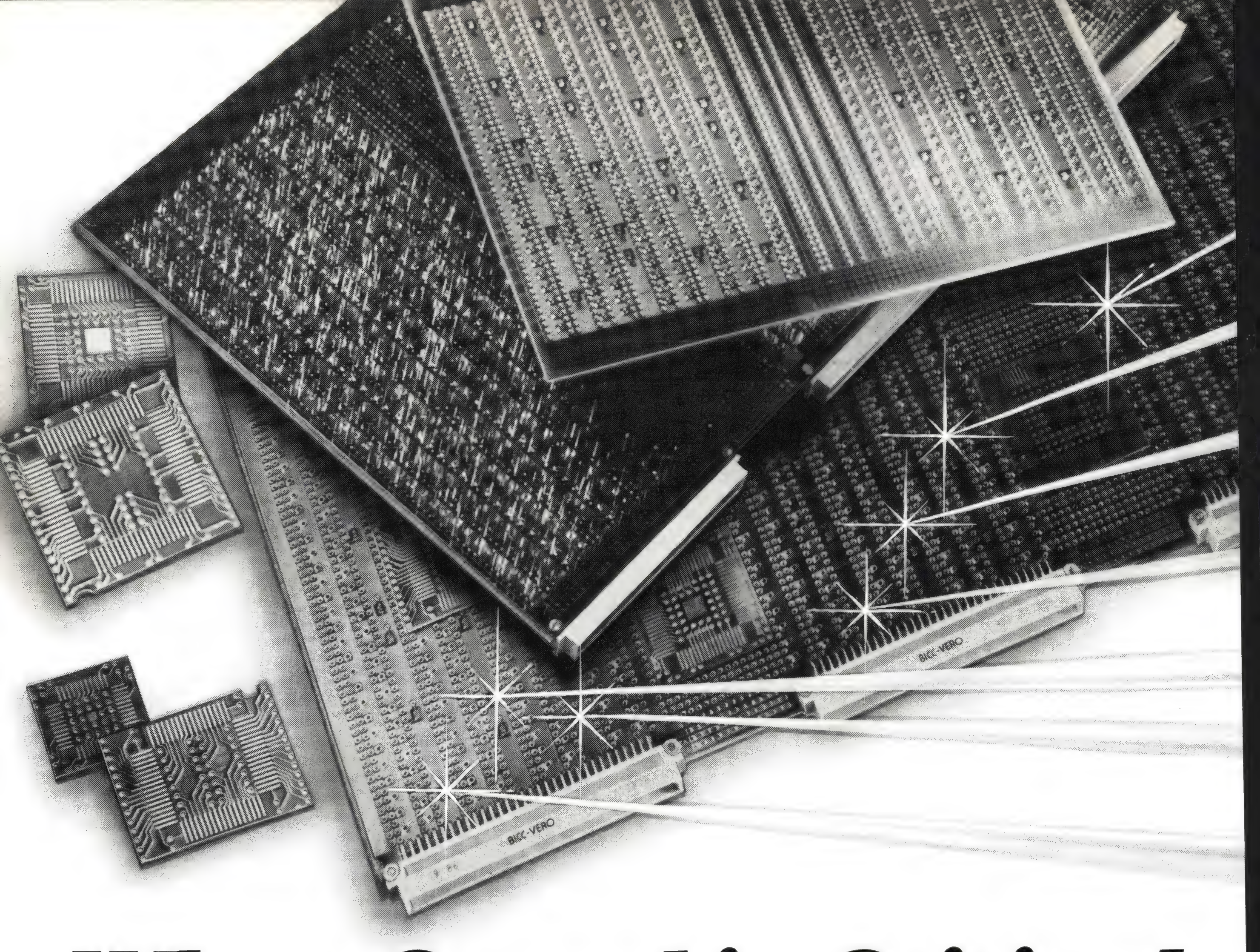

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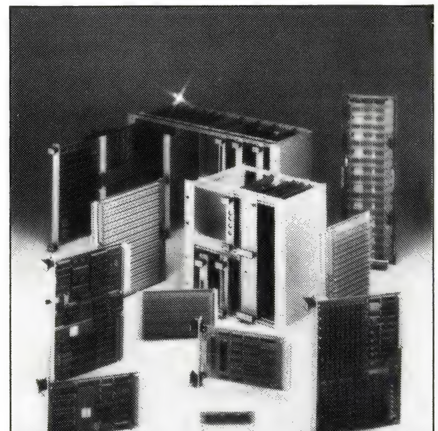

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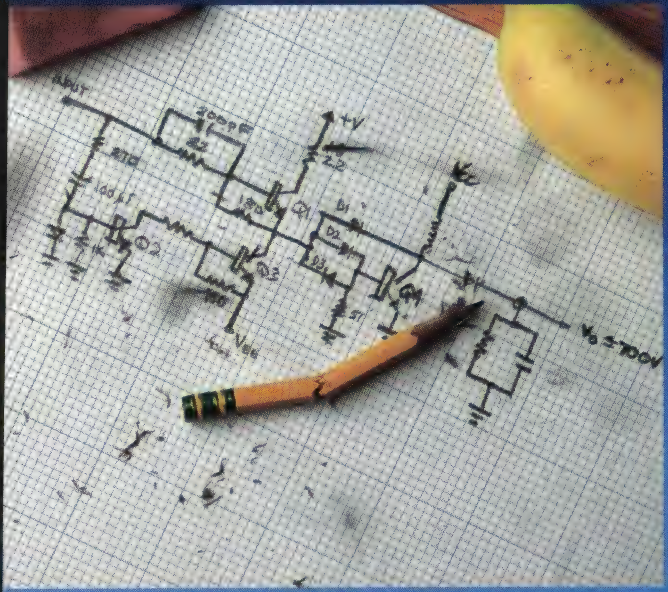

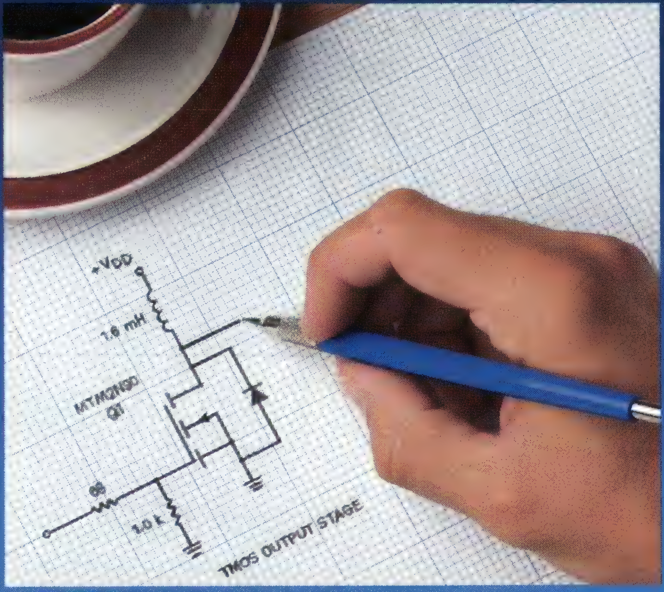

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MTM3N100	1000	N-CH
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MTM3N95	950	N-CH
MTM5N95	950	N-CH
MTM2N90	900	N-CH
MTM4N90	900	N-CH
MTM6N90	900	N-CH
MTM2N85	850	N-CH
MTM4N85	850	N-CH
MTM6N85	850	N-CH
MTM3N80	800	N-CH
BUZ84	800	N-CH
BUZ84A	800	N-CH
MTM3N75	750	N-CH
2N6823	600	N-CH
MTM3N60	600	N-CH
2N6826	600	N-CH
MTM6N60	600	N-CH
MTM8N60	600	N-CH

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Part Number	Voltage	Polarity
MTH5N100	1000	N-CH
MTH5N95	950	N-CH
MTH6N90	900	N-CH
MTH6N85	850	N-CH
MTH6N60	600	N-CH
MTH8N60	600	N-CH

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Part Number	Voltage	Polarity
MTP2P50	500	P-CH
MTP1N100	1000	N-CH
MTP3N100	1000	N-CH
MTP1N195	950	N-CH
MTP3N95	950	N-CH
MTP2N90	900	N-CH
MTP2N85	850	N-CH
MTP4N85	850	N-CH
MTP3N80	800	N-CH
MTP3N75	750	N-CH
MTP1N60	600	N-CH
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MTP3N60	600	N-CH
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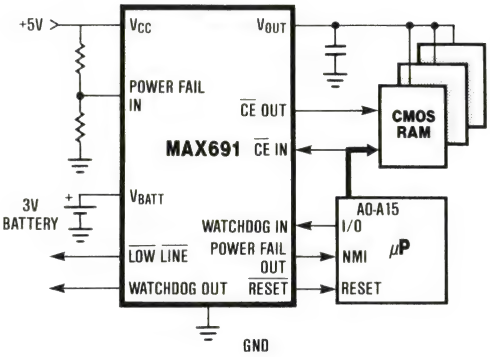

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The MAX690 and 691 have a precise 4.65V threshold detector and 50ms timer that generates an accurate reset signal for any power-on, brown-out or momentary interrupt condition.

Internal Watchdog Timer.

A watchdog circuit built into each MAX690/691 constantly monitors all μP activity. It detects both hardware and software malfunctions and automatically issues a reset command to the μP—effectively eliminating 'lock-up' conditions.

Automatic Battery Switchover.

The MAX690 and 691 constantly monitor incoming power and automatically switch to battery back-up mode when the power supply drops below the battery voltage. This lowers quiescent current to less than 1μA and ensures that data in CMOS RAM or EEPROM remains intact until power is restored.

Power-Fail Detection.

An uncommitted 1.25V threshold comparator is built into each MAX690/691 for use as a power-fail indicator or for monitoring the back-up battery voltage. Like many of the functions on-board the 690/691, built-in power-fail detection can save you components and valuable design time.

Both the MAX690 and MAX691 are available in DIP and S.O. packages and—like every other Maxim part—each is tested to rigorous reliability standards absolutely free. At $3.30* and $3.80* respectively, they offer you a price/performance value unmatched in the marketplace.

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* 100-up price

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CIRCLE NO 124

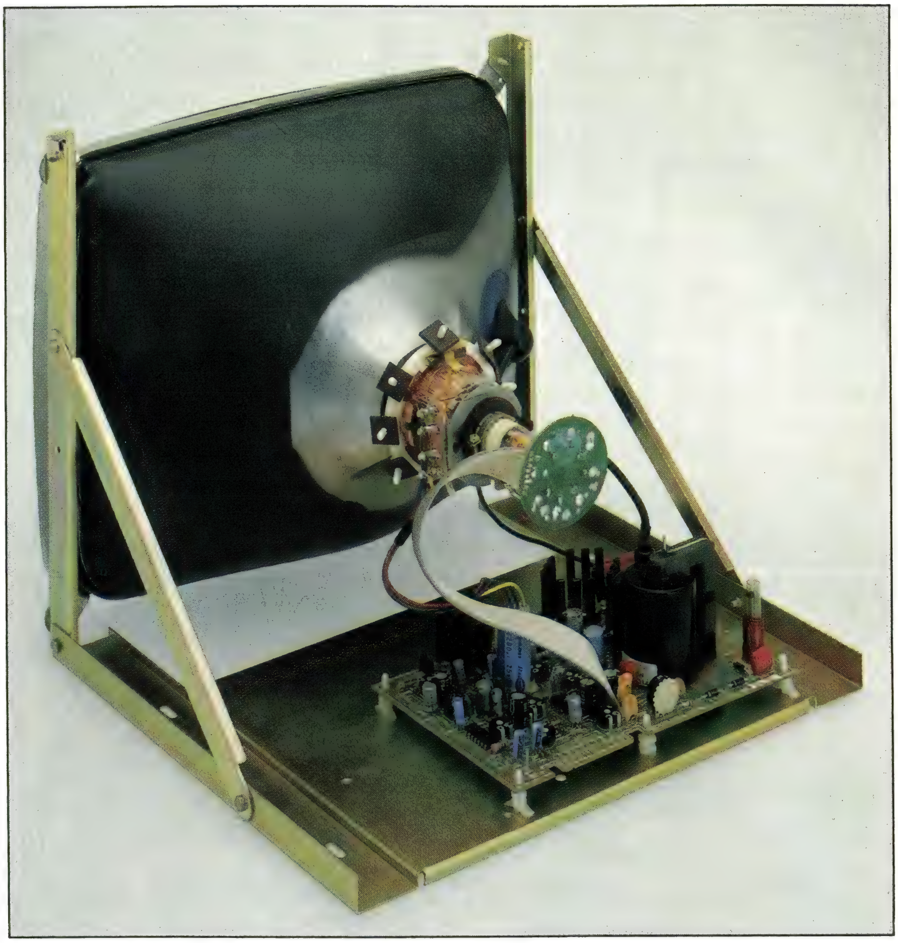
Refinements in CRT design boost resolution of color video monitors

Chris Terry, *Associate Editor*

It's easy to forget that as recently as a few years ago, color video monitors couldn't produce the finely detailed images needed for even moderately complex CAE applications. Both monochrome and color monitors of the early 1980s offered fairly low resolutions—350×250 to 640×250 pixels—so the images they produced were often fuzzy.

Today, however, you can find color monitors that provide resolutions from 640×480 to 2048×2048 pixels. These monitors are suitable for use in electronics-design workstations as well as in mechanical- and structural-engineering workstations and systems that provide fast animation, such as training simulators.

Furthermore, these monitors are not prohibitively expensive—an important factor, because the monitor represents one of the biggest system-component investments you'll make when you're putting together a graphics system. The latest color monitors now cost between $3000 and $10,000.



Available as a kit, mounted on a chassis, or enclosed in a cabinet, *the 300DMX from Computron provides 1040×1040-pixel resolution on a 9-, 12-, or 14-in. screen.*

New developments

The high resolutions of these color monitors result from a number of developments in monitor design. The amount of detail that a color monitor can display is governed by the resolution the tube is capable of and the accuracy of its color registration. The total number of colors in your palette and the number of colors that you can display simultaneously are both functions of the way the graphics display-generator board stores the screen position and color attributes of each pixel. The display-generator board supplies vertical and horizontal synchronization signals to the monitor together with the RGB components of the video signal.

Although a resolution of 640×350 pixels is adequate for many applications, most CAE applications—particularly those that involve mechanical drawings—demand much better definition. High-resolution monitors generally display at least 1024×1024 pixels (that figure is, incidentally, the resolution specified by the proposed European high-definition television standard).

The number of pixels that a screen can accommodate largely depends on the size of the spot that the lensing system of the tube can produce—the smaller the spot, the more pixels the screen will accommodate horizontally and vertically.

Recent refinements in the technology of electrostatic lens systems have allowed monitor designers to bring the minimum spot size down to 0.26 mm; however, the difficulties and cost of fabricating tubes that have such a small spot size make them uneconomical. A few vendors (such as Computron, Philips, and Mitsubishi) offer tubes with

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CIRCLE NO 123

a spot size of 0.28 mm, but the majority of vendors offer monitors with a 0.31-mm size. The 0.31-mm spot size provides a resolution as high as 1024×1024 pixels on 17-in. or larger screens and 2048×2048 pixels on 20-in. or larger screens, and allows the vendors to keep the monitors' prices under $3000.

The lens refinements that have allowed the decrease in spot size also entail a reduction of the lens aperture size with respect to the beam size, so they pose some problems in maintaining brightness, especially in color tubes, in which beams from three electron guns (for red, blue, and green) must all pass through the same lens system. To increase the brightness, the manufacturer must pass a larger beam current through the lens to produce stronger excitation of the phosphor. If the beam current increases beyond a certain limit, however, it starts to heat the lens system, thereby causing defocusing or distortion. The safe limit is somewhat dependent on aperture size, so that reducing the spot size may also entail a smaller light output from the screen. The most recent color tubes have better light output than their predecessors do, but they still don't achieve as much light output as do monochrome tubes.

Also critical for high resolution and good color registration is the color tube's shadow mask. The smaller the holes in the shadow mask, the higher the resolution. However, the difficulty and cost of fabricating a shadow mask increase as the size of the holes decreases.

Different types for varied uses

When you evaluate a monitor for use in your system, you need to know whether it has a fixed or flexible scanning rate. If you're selecting a color monitor for incorporation in an integrated CAE workstation, for example, you'll need the monitor to provide a fixed resolution, so it will operate optimally with your system's particular display-generator board. If you're selecting a monitor for use with a microcomputer system that can accept a Color Graphics Adapter (CGA), Enhanced Graphics Adapter (EGA), Professional Graphics Adapter (PGA), or Video Graphics Array (VGA) display board, you'll want the monitor to be able to adjust to different resolutions.

***Its flexible scan rate** makes the XC-3710C color monitor compatible with the CGA, EGA, and PGA display generators. The 37-in. monitor, from Mitsubishi, offers a resolution of 640×480 pixels.*

Among the recent offerings of fixed-resolution monitors is Computron's 300DMX, which has a fixed scan rate of 64 kHz and a resolution of 1024×1024 pixels; this monitor is available as a kit (tube and electronics unmounted), mounted on a chassis, or enclosed in a cabinet. You can also order it with a 9-, 12-, or 14-in. tube. Prices start at $186 (in OEM quantities) for the kit configuration.

If you want even higher resolution, consider Mitsubishi's $3790 HG-6905BK color monitor. This 20-in., stand-alone unit tracks horizontal scanning frequencies of 40 to 70 kHz and vertical scanning frequencies of 50 to 75 Hz, and it provides a resolution of 1280×1024 pixels. You can switch the input between 90 to 132V ac and 198 to 264V ac for use anywhere in the world, and the high-voltage stabilizer maintains picture size and brightness when the picture switches from low to high illumination or vice versa.

Some monitor vendors provide both fixed- and variable-resolution types in similar configurations. Conrac, for example, offers its 19-in. Model 7350 for $2995; the monitor automatically tracks the display board's horizontal scanning frequency from 15.75 to 37 kHz, providing resolutions as high as 1024×1024 pixels. The 19-in. Model 7351 provides a fixed scan rate of 64 kHz for a single 1280×1024-pixel display format; it costs $3495.

If you need a really large screen—37 in., for example—consider the Mitsubishi XC-3710C. The monitor tracks horizontal scanning frequencies from 15 to 31.5 kHz and vertical scanning frequencies from 40 to 75

For more information . . .

For more information on the color monitors discussed in this article, contact the following manufacturers directly, or circle the appropriate numbers on the Information Retrieval Service card.

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Circle No 717

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Hz, and it provides resolutions as high as 640×480 pixels. It operates with CGA, EGA, and PGA display boards, and it accepts standard NTSC video signals from VCRs and laser-disk equipment. Its price depends on the options you order, but even the most complex configuration costs less than $10,000.

The M37 Series color tubes from Philips International provide a spot size of 0.29 mm and resolution of 800×600 pixels at a modulation depth of −9 dB; you can obtain even greater resolution if you decrease the modulation depth. These 14-in. tubes are also distinguished by an internal magnetic shield that provides excellent immunity against stray magnetic fields. You can choose from a variety of yoke assemblies that operate with horizontal scan rates of 16 kHz to as much as 64 kHz. The M37 Series color tubes start at $125.

Another critical item in a high-quality color monitor is the power supply. High-resolution monitors may consume as much as 200W, much of which is dissipated in the monitor's deflection yoke, so the yoke design is an important factor in the monitor's reliability. The regulation of the high-voltage supply is also critical; a poorly regulated supply will cause raster size and light output to change when the picture suddenly switches from a few bright lines to full illumination, or vice versa. In extreme cases, the focus may also suffer.

To find out how good the monitor's high-voltage regulation is, you can either check the data sheet for black-level stability specs, or you can perform a simple test: You call up a page containing some scattered text characters and switch the page from normal video to reverse video. When you switch to reverse video, the characters should remain sharp and clean; any blurring of characters is a sign of poor high-voltage regulation.

Finally, you should check to see that the switching power supply is shielded, because any radiation from the power supply can introduce noise that degrades the picture. Units that provide fixed-frequency scanning should also allow you to tune the power supply to synchronize the switching frequency with the scanning frequency; this procedure eliminates beat frequencies that could interfere with the picture. **EDN**

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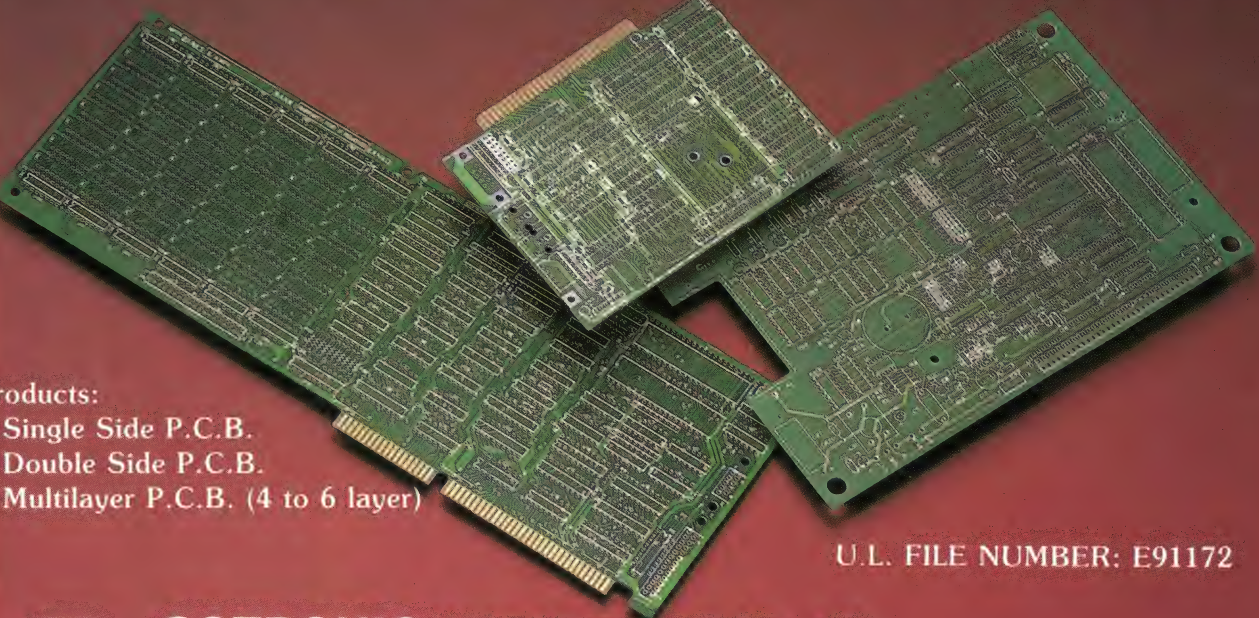

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- Programmable interrupt system
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- Timekeeping from 1/10 sec. to years
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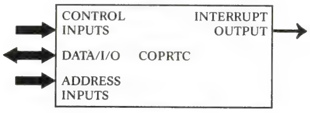

The COPRTC Real-time Clock peripheral has a direct interface to the COP800. It's 32 KHz crystal oscillator allows independent operation while the controller core cell is in a low-power halt state. The interrupt timer can "wake up" the controller at user-programmable intervals. This peripheral keeps time with tenth-second resolution and includes an automatic leap year calculation. Of course, it is also fully compatible with all the digital and analog cells in our Triple Technology™ 2 micron CMOS cell library.

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Key Features:

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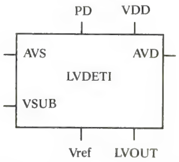
Negative going trip point, Vtr−	3.7			Volts
Positive going trip point, Vtr+			4.5	Volts
Hysteresis (Vtr+)−(Vtr−)	200			mV



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CIRCLE NO 78

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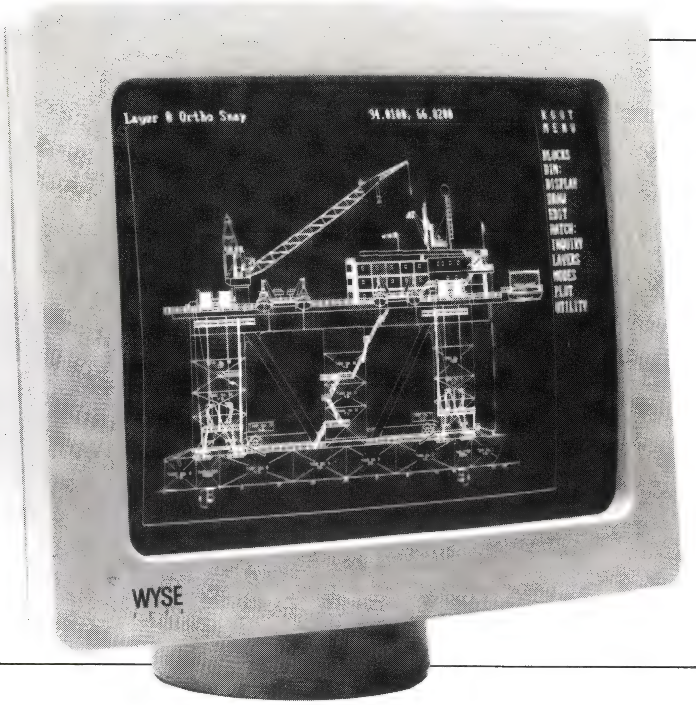

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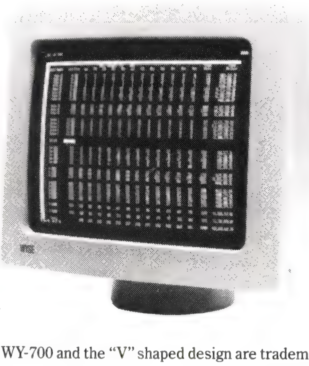

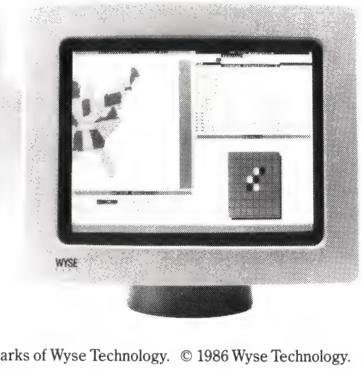

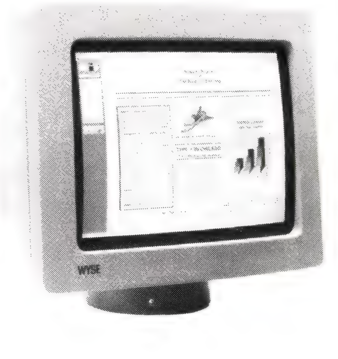

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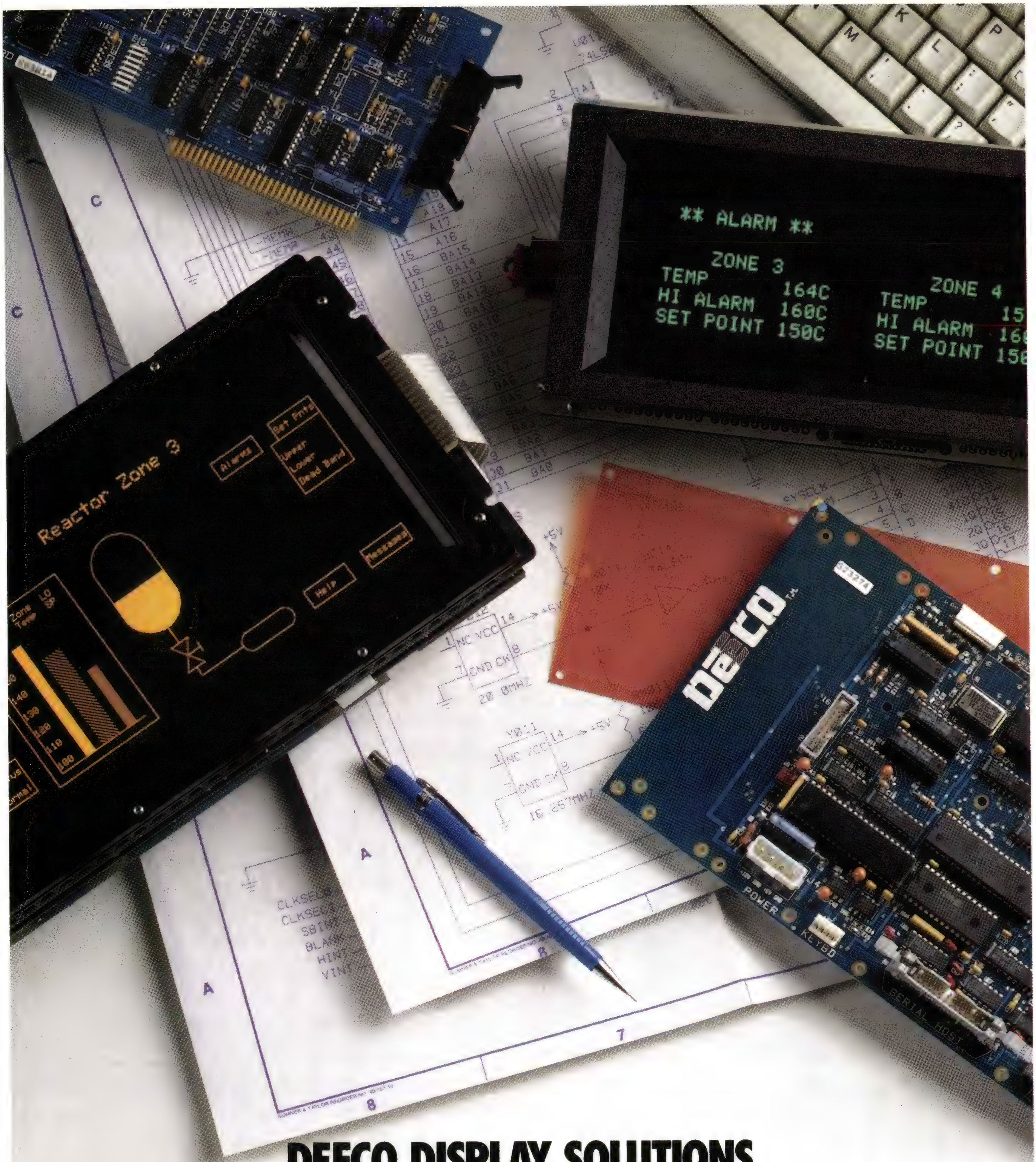

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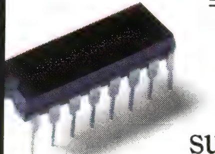

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We make a really fast 2K x 8 static RAM – 25 ns. And we were first to introduce the 8K x 8 CMOS static RAM. Today we lead the industry in byte wide memory products with the 32K x 8 (256K) CMOS static RAM available in volume.

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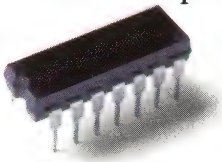

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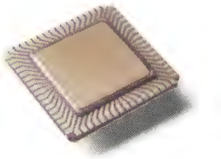

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Sometimes, keeping a low profile pays off.

The survival of today's combat helicopter depends on keeping a low profile. Abbott's BC100 triple output, switching DC-DC converter helps the Lynx helicopter achieve this low profile.

The BC100's low 1.875″ profile allowed 100 watts to fit into a tight space requirement. At the same time, the Lynx helicopter was able to take advantage of the economy and reliability that come from using a standard product, the BC100.

Because the BC100 meets the requirements of MIL-STD-810C, and MIL-S-901C, the Lynx program's decision to go with Abbott's BC100 will also pay off in extra survivability. Plus the BC100 features low ripple/noise and EMI within the limits of MIL-STD-461B.

For other applications that call for small yet powerful converters, Abbott offers both 100 and 200 watt models. Each available in single and triple configurations. And all with a wide array of options available.

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Abbott Transistor Laboratories, Inc. Power Supply Division, 2721 S. La Cienega Blvd., Los Angeles, CA 90034 (213) 936-8185. Eastern Office: (201) 461-4411, Southwest Office: (214) 437-0697, London Office: 0737-82-3273.

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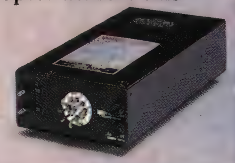
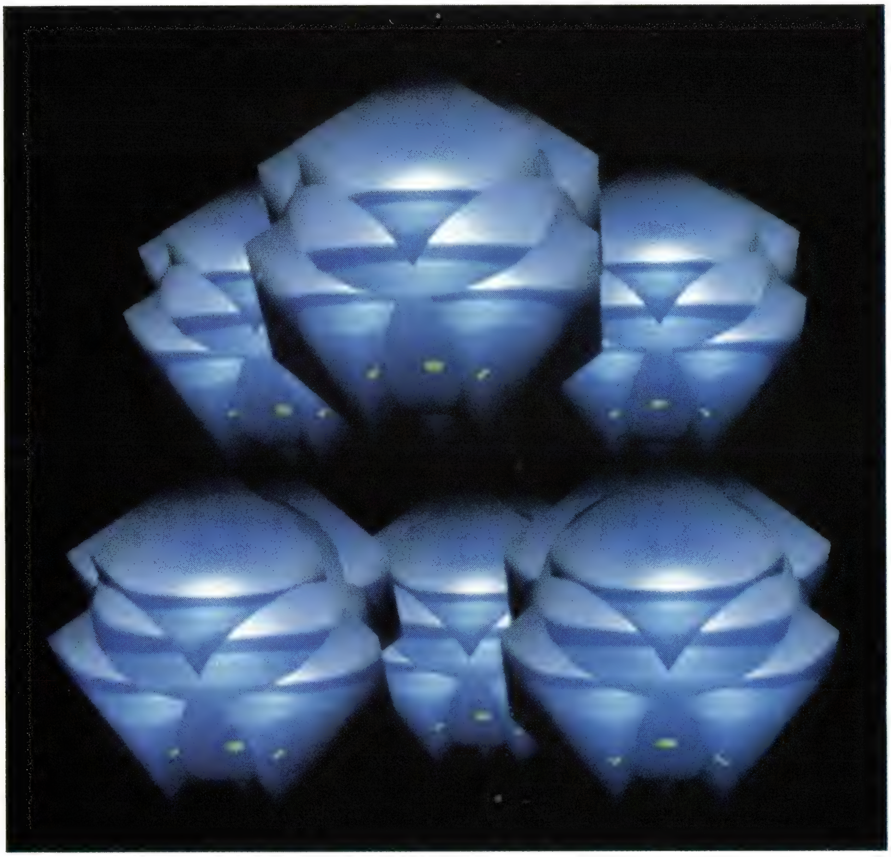


Wescon/87 will highlight electronics in the entertainment and broadcasting sectors

Charles H Small,
Associate Editor


The theme of Wescon/87 is *"Electronics in Entertainment and Broadcast." The Electronic Theatre will emphasize that theme with a session on "Computer graphics animation," which will present animated examples. (Photo courtesy BTS Broadcast Television Systems Inc)*

Wescon/87, with the theme of "Electronics in Entertainment and Broadcast," will take place from November 17 through 19 at three locations in San Francisco, CA: Moscone Center, Civic Auditorium, and Brooks Hall. Wescon officials expect 50,000 attendees, 1800 booths, and 800 exhibitors.

The show's sessions will explore new methods of applying technology with current tools. They will also present nontechnical issues, such as the benefits of ASIC design centers and how to protect new technology from competitors—and yourself.

Virtually all sessions will be held in the Moscone Convention Center, and you will incur no additional charges when attending the professional programs. Professional-program speakers this year include 30 company presidents or vice presidents, 27 technical vice presidents, 47 marketing managers, and 29 engineers. The speakers represent 125 different companies from 20 states and three foreign nations.

Keynote speaker

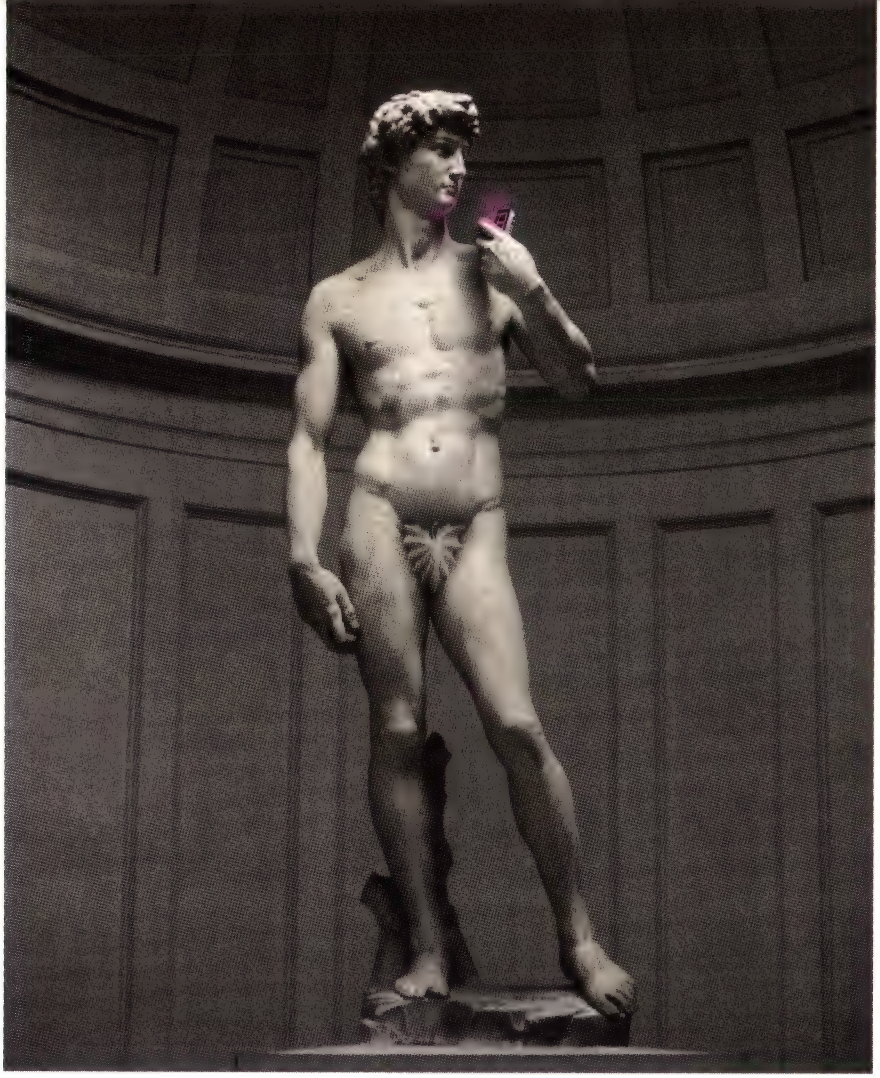
Charles S Steinberg, CEO of Ampex Corp, will deliver the keynote address at a special luncheon to be held at noon in the Cabernet Room of the Meridien Hotel. Tickets for the luncheon cost $25. Steinberg, known as "Mr Olympics" for his behind-the-scenes attention to the technology that has given audiences front-seat viewing of the Games since 1964, will tell an engaging story of entertainment technology—past, present, and future.

In addition to free exhibits and technical sessions, Wescon will have business conferences on subjects such as the state of the entertainment-electronics business, commercialization of superconductivity, improving the bottom line, just-in-time theories, investing in electronics, and doing business in the Pacific rim.

A special exhibit will feature the latest hardware that creates the sights and sounds of today's world. Among the products on display will be a 1-in. videotape recorder and the ADO (Ampex Digital Optics) special-effects device from Ampex Corp (Redwood City, CA). You can also experience the Emulator II—a computer-based digital musical synthesizer from E-Mu Systems (Scotts Valley, CA). The exhibit will showcase video-digitizing equipment and a mobile broadcast van.

In addition to static displays, you will be able to see videotapes of avionics, engineering-design, and graphics-modeling systems from Robert Bosch Corp and Evans and Sutherland—both of Salt Lake City, UT. The special exhibit, located in the Civic Auditorium, will be open during regular show hours at no charge.

The show will feature a free Elec-



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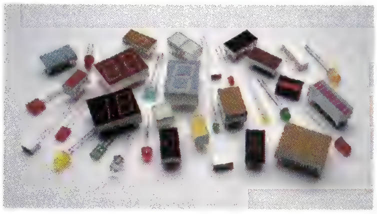

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CIRCLE NO 101

tronic Theater, which will be located in the Civic Auditorium. The Electronic Theater will present a session exploring applications of leading-edge technologies each morning at 9:30. For example, on Tuesday, a show entitled, "Television and special event communications—the concept and how it can help you," will detail how intercommunications systems can communicate simultaneously in network fashion. This session's organizer, Robert Turkow of Clear-Comm Intercom Systems, gathered first-hand experience coordinating communications for the 1984 Summer Olympics and the 1986 Fourth of July Liberty Weekend.

Animated graphics

Wednesday, the Electronic Theater opens its doors with a session on "Computer graphics animation." The session, organized by Allen Jensen of BTS Inc, starts with a historical perspective of computer graphics animation and ends with a discussion of the current state of the industry. The show will present animated examples.

Thursday begins with a session on "Digital signal processing for television broadcast," organized by Fraser Morrison of Ampex Corp. The session will present a description of some of the processing operations necessary to generate and manipulate television signals.

Each afternoon, from 2:30 to 4:30, the Electronic Theatre will present selections from the "1986 ACM/SIG-

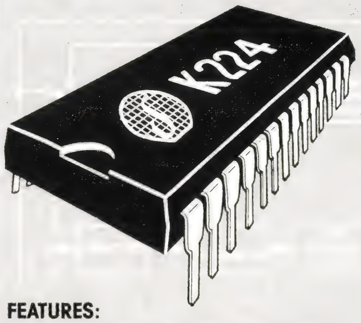
WESCON/87 TECHNICAL-SESSION PROGRAM

		BALLROOM F	BALLROOM G	BALLROOM H	MERIDIEN HOTEL (SAUTERNES BALLROOM I, II, III)
TUESDAY, NOVEMBER 17	9:00 AM TO 11:00 AM	(1) MICROCONTROLLERS MAKE THE 8- TO 16-BIT TRANSITION	(2) SOFTWARE VALIDATION AND VERIFICATION	(3) DEBUGGING AND INTEGRATION OF EMBEDDED SYSTEMS: CURRENT ISSUES	
	12:30 PM TO 2:30 PM	(4) THE 32-BIT RISC VS CISC CONTROVERSY	(5) NEW CAD TOOLS INTEGRATE PLDs, GATE ARRAYS, AND STANDARD CELLS	(6) MODERN METHODS IN DIGITAL SIGNAL PROCESSING	
	3:00 PM TO 5:00 PM	(7) NEW WAVE OF HIGH-PERFORMANCE VLSI PERIPHERAL CHIPS	(8) PC BASED CAD—COMPUTER-AIDED DESIGN OR COMPUTER-AIDED DISASTER? A USER'S PERSPECTIVE	(9) HIGH-VOLUME MICROWAVE APPLICATIONS	
WEDNESDAY, NOVEMBER 18	9:00 AM TO 11:00 AM	(10) PLDs. . . ARE THEY A DESIGN STEPPING STONE OR DO THEY OFFER LONG-TERM DESIGN AND MANUFACTURING SOLUTIONS?	(11) PHOTOVOLTAIC TECHNOLOGY AND SYSTEMS FOR THE 1990s	(12) ADVANCES IN BUS INTERFACE	(13) ELECTRONICS BUSINESS IN CANADA
	12:30 PM TO 2:30 PM	(14) QUICK-TURN ASICs; AN ELIXIR FOR SHORT PRODUCT LIFE CYCLES	(15) MICROPROCESSOR TECHNOLOGY AND APPLICATIONS FOR POWER SYSTEMS; DATA ACQUISITION AND CONTROL	(16) A FACTORY-FLOOR PERSPECTIVE OF COMPETITIVE BUS STRUCTURES	(17) NEW TECHNOLOGY—PROTECTING IT AND PROTECTING YOURSELF FROM IT
	3:00 PM TO 5:00 PM	(18) APPLICATION-SPECIFIC PLDs—A NEW THRUST	(19) PERSONAL-COMPUTER-BASED DATA ACQUISITION AND CONTROL	(20) SERVICES, ISSUES, AND TECHNOLOGY IN THE REALIZATION OF INTEGRATED SERVICES DIGITAL NETWORK (ISDN)	(21) BENEFITS OF ASIC DESIGN CENTERS
THURSDAY, NOVEMBER 19	9:00 AM TO 11:00 AM	(22) PROGRAMMING MICROCONTROLLERS —NEW SOFTWARE ENVIRONMENTS	(23) THERMAL CONSIDERATIONS IN SURFACE-MOUNT TECHNOLOGY	(24) SILICON SENSOR AND MICROSTRUCTURE TECHNOLOGY	
	12:30 PM TO 2:30 PM	(25) CMOS CORE PROCESSORS—THE KEY TO HIGH-PERFORMANCE ASIC	(26) POWER CONVERSION	(27) REAL-TIME MULTIPROCESSING TECHNOLOGIES	
	3:00 PM TO 5:00 PM	(28) HIGH INTEGRATION TECHNOLOGY FOR PERSONAL-COMPUTER DESIGN	(29) FLAT-PANEL TECHNOLOGY—"THE MEMBRANE ALTERNATIVE"	(30) LOW-POWER GaAs GATE ARRAYS—ALTERNATIVE TO HIGH-POWER ECL ARRAYS IN HIGH-SPEED SYSTEM DESIGN	

NOTE: ALL SESSIONS WILL BE HELD IN THE MOSCONE CONVENTION CENTER UNLESS OTHERWISE NOTED.

SPOTLIGHT #29
IN A SERIES

NEW
2400 BPS
CCITT V.22 BIS
SINGLE-CHIP MODEM



FEATURES:

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- FSK (300 BPS), DPSK (600, 1200 BPS), or QAM (2400 BPS) encoding
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Silicon Systems now offers the industry's most highly integrated modem IC—the SSI K224. It is a single-chip modem IC that provides all the functions needed to construct a V.22 bis compatible modem, capable of 2400 BPS full-duplex operation over dial-up lines. The SSI K224 offers excellent performance and a high level of functional integration in a single 28 pin DIP. This device meets world-wide standards and supports all modes of operation, allowing both synchronous and asynchronous communication.

The SSI K224 is ideal for use in either free-standing or integral system modem products such as lap-tops, P.C.'s and portable terminals, or wherever full-duplex 2400 BPS data communications over the 2-wire switched telephone network is desired.

The SSI K224 is pin and software compatible with the SSI K212, K221, and SSI K222 single-chip modem IC's, allowing system upgrades with a single component change.

For more information on the SSI K224 and the complete SSI K-Series modem IC family, contact: **Silicon Systems,** 14351 Myford Road, Tustin, CA 92680. Phone: **(714) 731-7110, Ext. 575.**

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Transportation and parking at Wescon

As anyone who's been to San Francisco knows, the parking situation there is horrendous. Therefore, Wescon officials recommend that you park at Candlestick Park if you're driving in. It costs $3, and you must be on your way out by 6:45 pm. If you take the BART (Bay Area Rapid Transit), get off at the Civic Center stop for (naturally) the Civic Auditorium and Brooks Hall. Get off at the Powell Street stop for the Moscone Center. If you travel by bus, take the 21 Hayes or 19 Polk for Brooks Hall and Civic Auditorium; take 15 Kearney or 30 Stockton for Moscone Center. The bus costs $0.75, and the drivers *do not* make change.

GRAPH convention video review" organized by Stephen Keith, ACM/SIGGRAPH local-groups coordinator. The show will feature outstanding examples of computer graphics. The Electronic Theatre will also show selected short subjects during lunch.

Technical sessions

The program of technical sessions will cover a multitude of interesting hardware and software topics.

Tuesday, November 17, will see three sessions on high-performance VLSI, three sessions on software-applications tools, and three sessions exploring system solutions.

For example, **Session 3** on Tuesday will cover debugging of integrated systems. **Session 4** will add more sound and fury to the controversy between 32-bit RISC and CISC computer instruction-set schemas. **Session 2** will delve into the ill-defined problem of software verification. And **Session 8** has the intriguing title of "PC-based CAD—computer-aided design or computer-aided disaster? A user's perspective." Those familiar with the generally small-production-volume microwave market might be curious about **Session 9**, "High-volume microwave applications."

Wednesday's agenda will include multiple sessions on programmable logic devices (PLDs), three on power systems, and three on data-acquisition and control, as well as sessions on bus interfaces, metastability, and ISDN. Programmable logic devices will get coverage in **Session 10**, which will pose the question: Are PLDs just a stepping stone to ASICs or a long-term solution in their own right? **Session 18** will cover a subject dear to the hearts of chip vendors who are tired of offering look-alike, general-purpose PLDs: application-specific PLDs. PC-based data-acquisition systems are catching the eye of engineers now that the systems are finally achieving a level of performance that professional engineers can use. Check them out at **Session 19**, "Personal computer based data acquisition and control."

Thursday's visitors to Wescon will find three sessions on new-generation single-chip μPs as well as discussions on SMT, flat-panel switches, silicon sensors, real-time programming, and GaAs devices. For example, **Session 22** will cover programming single-chip μPs and discuss new software environments; **Session 27** will highlight real-time programming for multiple CPUs.

EDN

Article Interest Quotient
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High 503 Medium 504 Low 505

“THEY SAID NO ONE COULD PUT IT ALL ON ONE CHIP.”

Introducing the SSI K224 With Everything You Want in a 2400 BPS Modem— With DSP on Chip.

"When we set out to design the universal modem IC that would meet 300 to 2400 BPS worldwide standards, even some of our best customers were skeptical. We knew existing solutions took a handful of IC's and separate DSP's for V.22 bis operation, requiring a lot of space and power. Our customers said they needed a single IC that would do it all, so it was only natural that we would come up with a chip that would meet their needs.

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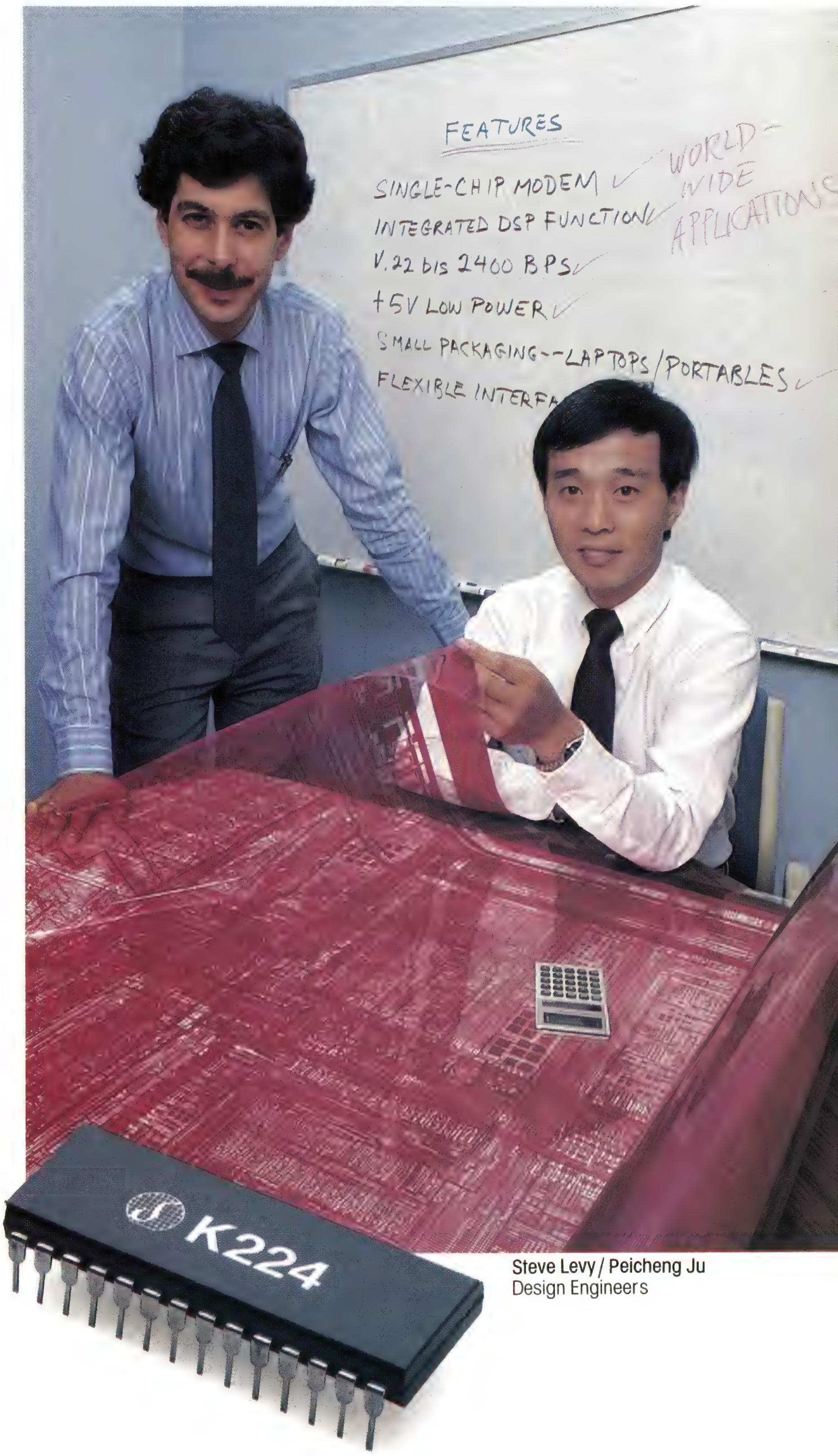

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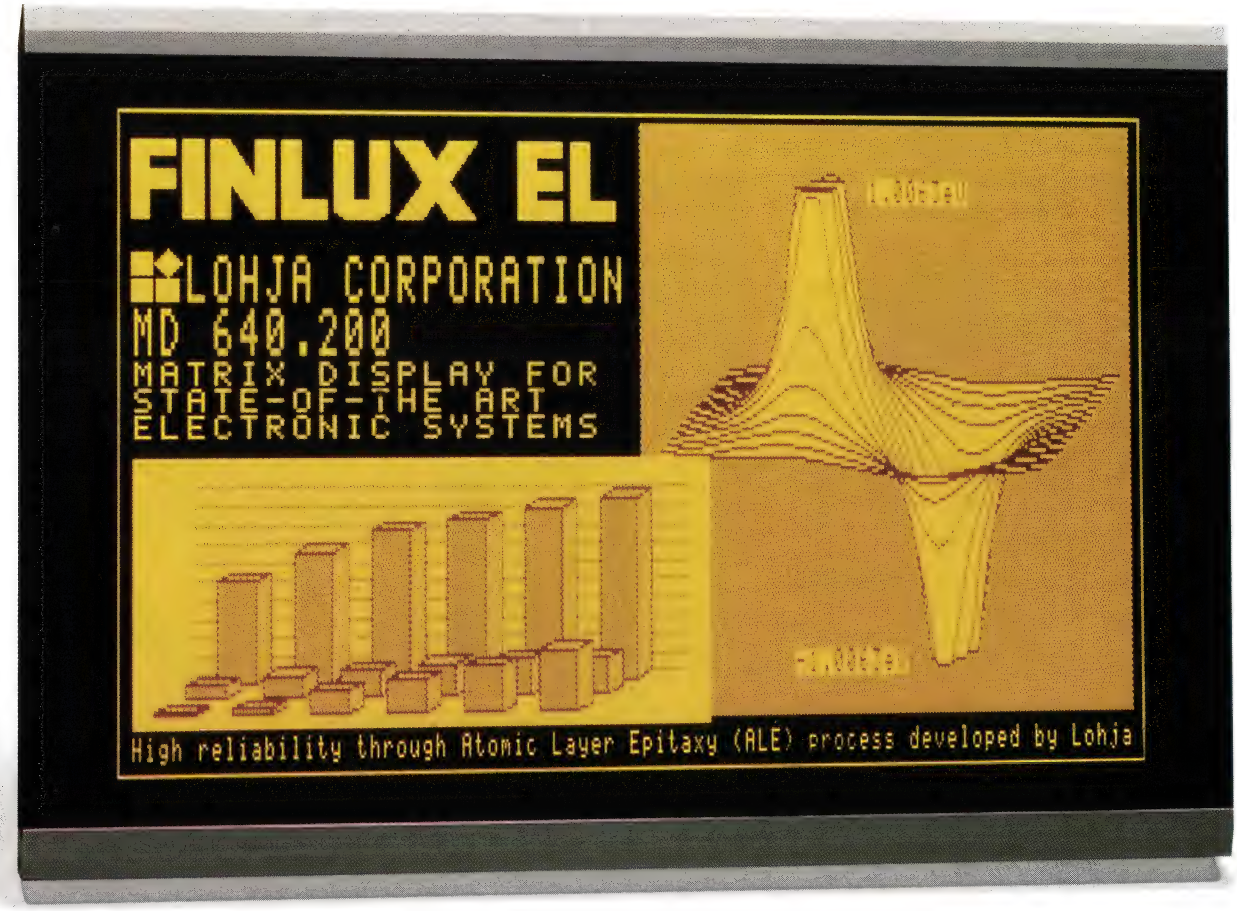

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MD512.256-33 -34 -35 -39 -37 -38	+5V/+15V +5V/+12V +5V/+12V +5V/+12V** +5V/+15V** +5V/+24V**	512 × 256 pixels	3.85 × 7.69 in. (195.2 × 97.7 mm) 1.04 in. (26.5 mm) D	5.67 in. (144 mm) H 10.2 in (260 mm) W	23 oz. (650 g)
MD640.400-50	+5V/+12V***	640 × 400 pixels	4.8 × 7.68 in. (122 × 195 mm)	6.24 in. (158.5 mm) H 9 in. (228.5 mm) W 0.72 in. (18.3 mm) D	13.4 oz. (375 g)

*Process developed by Lohja Corporation, Finland. **With integrated power supply and low power drivers. ***Available fourth quarter 1987.

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CIRCLE NO 100

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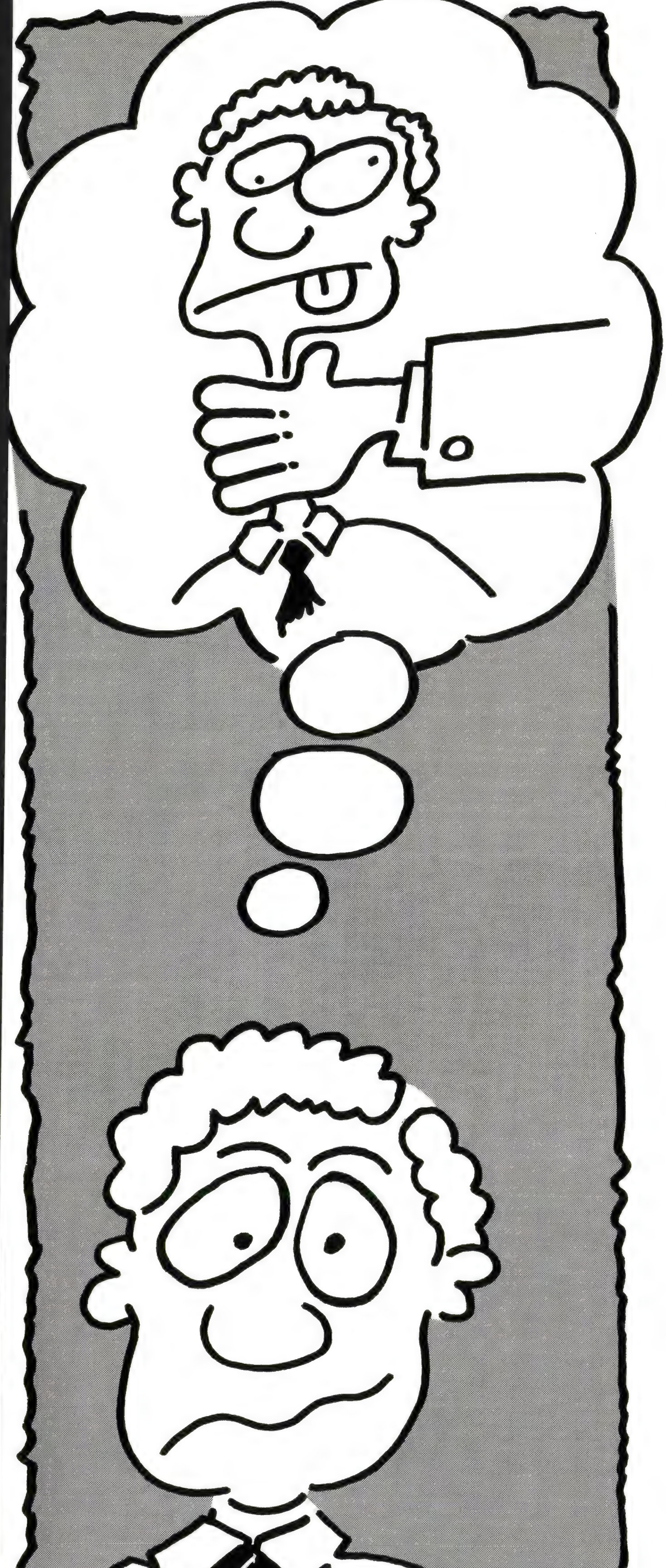

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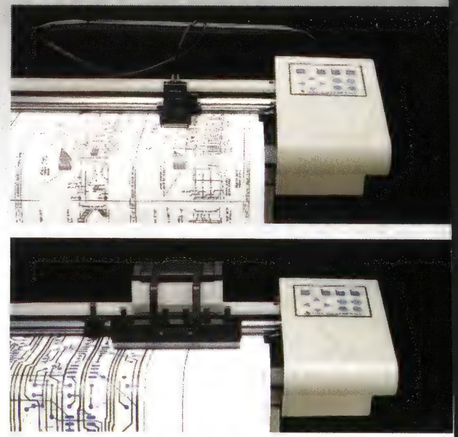

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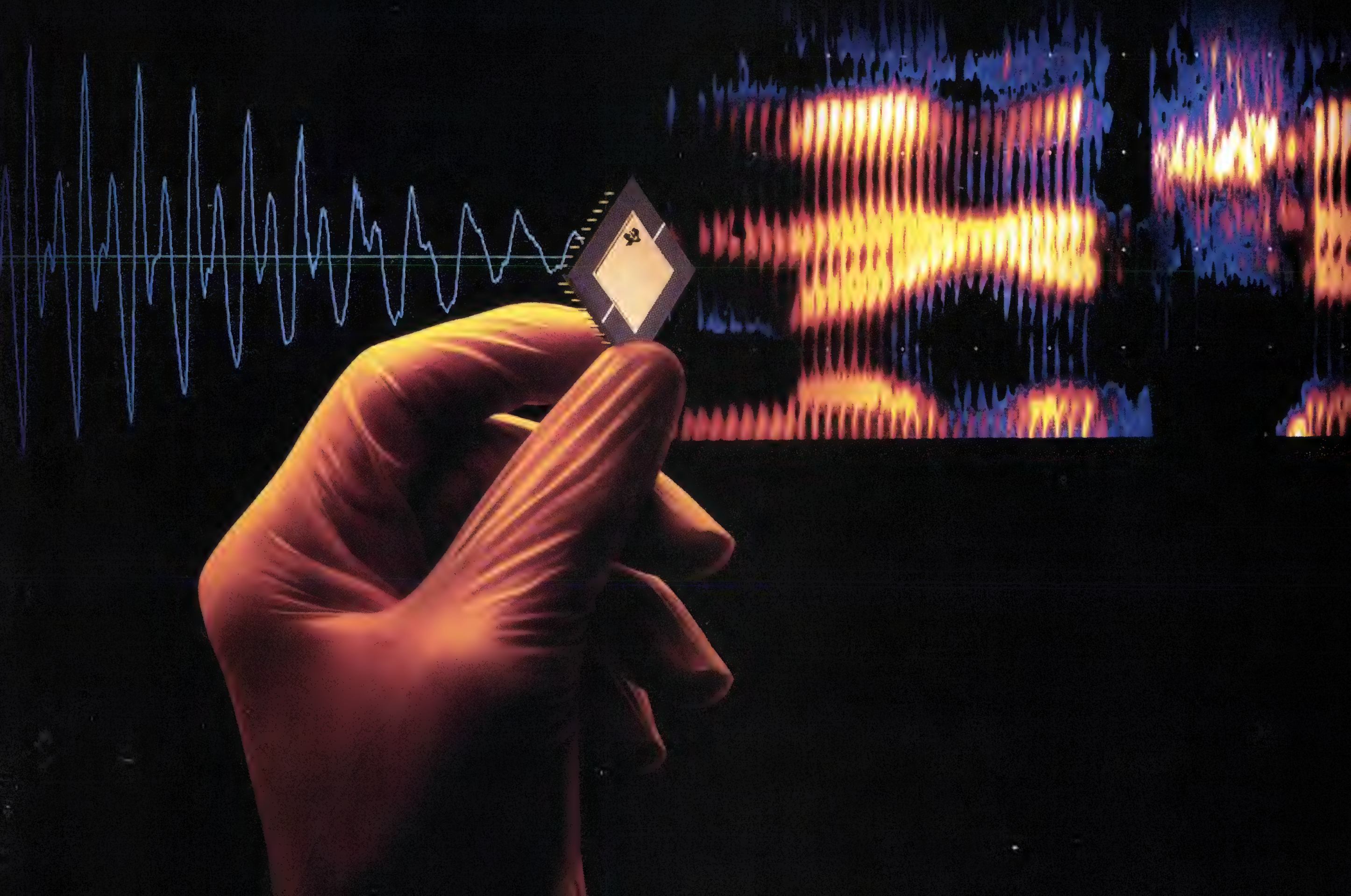
CIRCLE NO 98

TEXAS INSTRUMENTS REPORTS ON

DSP

IN THE ERA OF

MegaChip□ TECHNOLOGIES



DSP in the Era of MegaChip Technologies:

Digital signal processor
are turning up winner

©1987 Worlds of Wonder, Inc. All righ

TI's TMS320 DSPs add high performance at costs low enough to open new worlds of applications — from a high-performance Formula 1 car suspension to an intelligent doll and everything in between.

The results are in. You can a
more performance at lower cost de
ing with the standard in digital sig
processors (DSPs), TI's TMS320 f
There are now even more reasons
ever to get the advantages of TI D
performance in applications where
realtime number crunching is esse

rom Texas Instruments
n all sorts of places.

se advantages can make a differ-
 in applications as wide ranging as
ems, disk servo controllers, sona-
s, and voice multiplexers to
trum analyzers and graphics
stations.
etting started in DSP design is
r with Texas Instruments training and support. But once you see what the TMS320 family can do, you'll want the features TI DSP can give your designs.

"Handling performance is up there next to speed in Formula 1 racing. TI's TMS320 gives us a real advantage — enough to win a Grand Prix." Peter G. Wright, Technical Director, Lotus Engineering

Lotus designed the active suspension in their Camel-Lotus-Honda Formula 1 car to approach the theoretical maximum-control point which gives the best balance between handling and performance. At racing speeds, each wheel is positioned by the TMS320-controlled hydraulics. A single TMS320 chip measures wheel forces and displacements and reads data from a body-mounted inertial platform. Then, in real time, the chip computes wheel position and controls actuators that adjust the suspension components to precise settings.

The TMS320 can also handle closed-loop engine control and more responsive braking systems, as well as many other automotive applications.

"The TMS320 helps us with one of our toughest tasks — designing toys with exciting features at prices that will sell." Dave Small, VP Engineering, Worlds of Wonder, Inc.

Worlds of Wonder is a pioneer in developing interactive toys and now has an innovative new doll named Julie™ Using a single TMS320 chip, Julie's designers are able to give her voice-recognition ability, coupled with synthesized speech and coordinated facial movement.

The TMS320 design expands the applications for affordable consumer products like solid-state answering machines, cellular phones, improved hearing aids, and animated electronic games.

TI's MegaChip Technologies

Our emphasis on volume manufacturing of high-density CMOS circuits is the catalyst for ongoing advances in how we design, process, and manufacture semiconductors and in how we serve our customers. These are our MegaChip™ Technologies. They are the means by which we can help you and your company get to market faster with better, more competitive products.

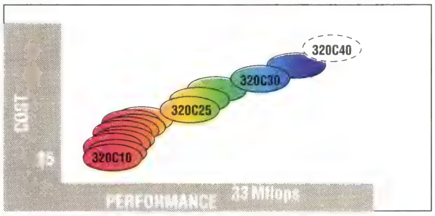
Winning designs come from a family of winners

There are 15 compatible members in the TMS320 family (*see the road map below*), featuring two new DSPs with on-chip EPROM, the TMS320E15 and the TMS320E17. For applications requiring off-chip memory, there is the new CMOS EPROM, the TMS27C292, with 35-ns speed.

New interface alternatives include the low-cost CMOS TCM29C18/19 Combo Codecs with A/D, D/A, and filters all on a single chip.

The high-performance TLC32040 Analog Interface Circuit has 14-bit A/D and D/A and programmable filters.

For higher performance in digital signal processing, you can use building-block products like TI's microcodable ACT88XX 32-bit processor family.

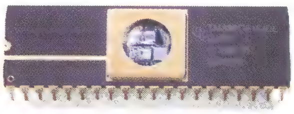


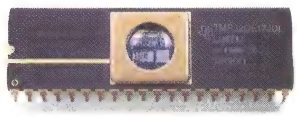
From $5 to 33 Mflops: With three generations covering 15 products, the TMS320 family offers software compatibility to protect your development investment and provide a smooth path to future applications.

For more information on support for the TMS320 family, please turn the page.

From hands-on training to a "C" compiler, TI has the tools you need to get your designs to market fast.

Whether you're moving into DSP or moving up in DSP, Texas Instruments can help you move your design into production faster.
Hands-on DSP Workshops using the TMS320 development tools cover all you need to know from architecture to software. Courses are scheduled at TI Regional Technology Centers.
Get Started in DSP with the TMS320 Design Kit, which contains data sheets, chip samples, and applications notes to make starting easy.
Count on EPROM DSPs for realtime code development, form-factor emulation, and early production runs, with the option for last-minute changes.





Applications Notes and Textbooks contain literally thousands of pages that are readily available to give you assistance in application concepts and designs.
Optimizing "C" Compiler reduces your time to market and preserves your software investment.
The Assembler/Linker and Simulator speed software development for you.
Realtime In-circuit Emulators allow you to integrate software and hardware and give you a final check.

More than 80 Third-party Hardware Suppliers and Consultants are featured in our *TMS320 Family Development Support Reference Guide* and in our DSP newsletter *Details on Signal Processing.*
TMS320 Bulletin Board is an on-line service that provides you with the latest technical and application information.

The TMS320 Technical Hotline is staffed by applications experts and i ready to take your call.

How to get a fast start

For more information on TI's TMS3 DSP family, call 1-800-232-3200, ex 3508. Or use the coupon below.

Texas Instruments Incorporated
P.O. Box 809066
Dallas, Texas 75380-9066

SPR173ED7

YES, please send me information on the following TI Digital Signal Processing produc and support services:

☐ PR01: TMS320 DSP Products
☐ PR02: Analog Interface Devices
☐ PR03: ACT88XX 32-bit Processor
☐ PR04: TI Regional Technology Center Workshops

NAME
TITLE
COMPANY
ADDRESS
CITY STATE ZIP
AREA CODE TELEPHONE EXT.

For more information on the Julie doll from Worlds of Wonder, Inc., call (415) 656-3171.

™MegaChip is a trademark of Texas Instruments Incorporated. Julie is a trademark of Worlds of Wonder, Inc.

TEXAS INSTRUMENT

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27-4511

Salon des Composants sessions will emphasize developments in passive components

Peter Harold, *European Editor*

Components for telecommunications, automotive systems, and industrial automation—three of Europe's fastest growing electronic-component markets—will figure prominently in the 28th Salon International des Composants Électroniques exhibition in Paris, France. The exhibition will take place November 16 through 20 at the North Paris exhibition grounds at Villepinte. With more than 1500 exhibitors occupying four halls at the site, the show will give you the opportunity to view the latest components in all fields of electronics. You'll also be able to listen to international panel discussions on quality-assurance programs and on the state of the semiconductor industry.

Despite its French name, the exhibition isn't mainly a French affair—752 of the 1261 manufacturers registered by September 1 were from countries other than France. In addition, 260 French distributors will be at the exhibition to display products from other non-French manufacturers. The show is divided into two sections: one dedicated to electronic components and subassemblies, and the other intended for electronic-test and -measurement and ATE equipment. Components, however, will continue to dominate the exhibition.

The international panel discussions, which are becoming a regular feature of the exhibition, will take place on Tuesday, November 17, and will be divided into a morning and an afternoon session. At the morning session, participants will discuss ways that the US and Western Europe can respond to the threat of Japanese dominance in the semiconductor industry. If you're an industry analyst, you'll want to attend this discussion. You'll have the opportunity to question the experts on whether collaboration agreements or mergers—such as the recent merger between Thomson Semiconductors (France) and SGS (Italy)—will be effective in helping the European semiconductor industry survive against both US and Japanese competition.

The afternoon session will focus on the cost and value of the quality-assurance programs, such as zero-defect policies, that some semiconductor manufacturers are currently offering. It will also examine the relative merits of ship-to-stock or just-in-time delivery programs. The participants will debate whether these policies and programs reflect users' real requirements, or whether they're merely a marketing ploy by the semiconductor manufacturers to capture greater market share.

A program of technical sessions will also accompany the exhibition this year: The Second International Conference on Passive Components will run from November 18 to 20. The conference will focus on advancements in technology that help passive components keep pace with semiconductor devices. The sessions will also deal with the passive aspects of active-device manufacture—for example, die mounting and packaging, soldering, and protection techniques.

A paper by an invited speaker will open each of the main conference sessions. The sessions will cover VLSI packaging and interconnection techniques, capacitors, connectors, resistive and protective devices, and optical components and human/system interfaces. In parallel with these main sessions will be sessions on magnetic materials and resistive devices, capacitors, and transducers. In total, three opening reviews, five papers from invited speakers, and 65 submitted papers will be presented over the 3 days.

Be sure to leave yourself plenty of time to walk the floors of the exhibition, however. Depending on the breadth of your interest in electronic components, it could easily take you two or three days to explore every manufacturer's offerings. Once you've satisfied your immediate information requirements, you may want to spend some time at the large semiconductor manufacturers' stands to see how today's technology will affect the automobiles and telecommunication systems of tomorrow. And at the end of the day, when you're footsore from tramping the exhibition floors, remember that the Paris nightlife is only 20 minutes away by Métro. **EDN**

For more information . . .

For more information on the Salon International des Composants Électroniques exhibition and the associated conference program, contact the following organizers directly.

SDSA
20 rue Hamelin
75116 Paris, France
Phone (1) 45051317
TLX 630400

Tables Rondes 1987
11 rue Hamelin
75783 Paris Cedex 16, France
Phone (1) 45057169
TLX 611045

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The Pioneers of Tomorrow's Military Display Technologies

For over 200 years the **American Pioneers**—the epitome of America's adverturesome spirit—have settled new frontiers on land, sea, air, and space. For over 40 years IEE has been part of America's pioneering team by developing hi-rel, state-of-the-art displays and keyboards for the military industry.

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- **Variety—**two display sizes: (4″×8″, 3″×5″) and a wide selection of data interfaces to choose from
- **User-friendly—**Optional infrared touchscreen available
- **Custom-engineering** capabilities: display sizes, data interfaces, enclosures, EMI/RFI shielding, and TEMPEST
- **Lower cost** "ruggedized" versions available

So, when your requirements call for flat-panel EL display modules, as well as LCD modules, keyboards, or terminals, call **IEE** for our product brochures, or come see us at AFCEA, Belgium, 4th Floor, Room 12

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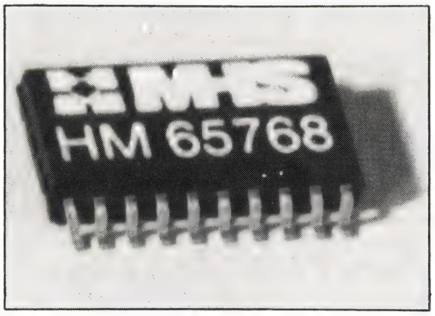
Circle 41 for for immediate application

Circle 80 for reference material

CMOS static-RAM families add high-performance and low-cost parts

Additions to the Comet family of high-speed 16k-bit CMOS static RAMs include the HM65767F, HM65768F, and HM65728H, all of which have faster access times than those of previous Comet family devices. The 16k×1-bit HM65767F and 4k×4-bit HM65768F have access times of 20 nsec, and the 2k×8-bit HM65728H has an access time of 25 nsec. The RAMs are available in versions that operate over the commercial and military temperature ranges, and they come in plastic or ceramic DIPs, small-outline surface-mount packages, or leadless chip carriers. Volume pricing for commercial-temperature-range devices in plastic DIPs and small-outline packages ranges from \$2.50 to \$7, depending on access time and organization.



The vendor has also added members to its HM65641 line of 8k×8-bit CMOS static RAMs. The additions include both high-performance and low-cost parts. The HM65641B has a 70-nsec access time. Its standby current is 50 μA, and its data-retention current, at a 2V supply voltage, is 20 μA. The company believes this part to be the lowest-power 8k×8-bit device on the market. The HM65641C is a low-cost version of the HM65641. It has an 85-nsec access time, a standby current of 500 μA, and a data-retention current (at 2V) of 200 μA. Both devices are available in versions that operate over the military and industrial temperature ranges, and both come in either 28-pin ceramic DIPs or 32-contact leadless chip carriers. Prices for military-temperature-range devices in ceramic DIPs range from \$46 to \$280, depending on access time, standby current, and quantity.

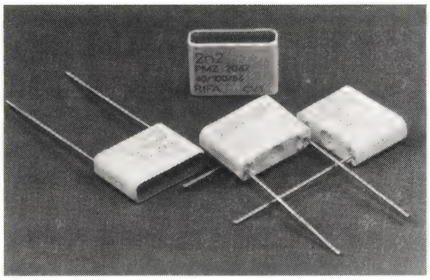
Matra-Harris Semiconducteurs, Centre de Guyancourt, 38 Blvd Paul Cézanne, BP 309, 78054 Saint-Quentin-Yvelines Cedex, France. Phone 1-30607000. TLX 697317. Hall 3, alley 36, stand 19.

Circle No 708

RFI-suppression capacitors handle 8-kV transients

Employing a self-healing paper dielectric that can withstand a dV/dt as high as 2000V/μsec, the PMZ2067 Series RFI-suppression Y capacitors can handle voltage transients as high as 8 kV. They are suitable for use in applications that require long component lifetimes and experience high-voltage transients. For protection against fire in the event of component failure, the capacitors are housed in a self-extinguishing epoxy resin encapsulation that meets the requirements of UL 94V-0.

These multilayer metallized-paper capacitors are available with capacitance values ranging from 0.001 to 0.022 μF, and they have a nominal capacitance tolerance of ±20%. They have a voltage rating of 250V ac at 50 Hz, and their operating temperature range is −40 to +100°C. Their recommended dc-operating-voltage limit is 1000V dc. At 1 kHz, the capacitors spec a dissipation factor of 1.3%. Their insulation resistance, measured at 23°C after 60 sec at 500V dc, is ≥1200 MΩ.



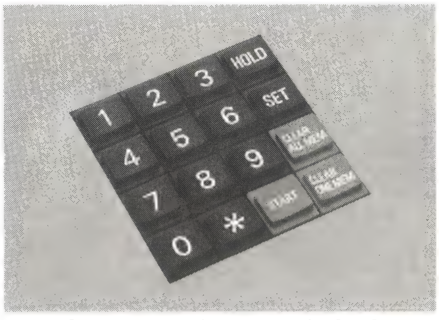
Each capacitor is tested to withstand a dc voltage of 2.7 kV, and each is subjected to a pulse test using a 10-kV peak, 1.2/50-μsec full wave, according to IEC-60. The capacitors' electrical and mechanical properties make them suitable for use in IEC-40/100/56 climatic category environments. The capacitors come in four case sizes ranging from 13×5.5×13.5 mm to 18×8.5×17 mm. The smallest case size has leads that are 10 mm apart; leads for all other case sizes are 15 mm apart. Around 6 Swedish krona (10,000).

Rifa AB, Box 945, 39129 Kalmar, Sweden. Phone (0480) 15660. TLX 43062. Hall 2, alley 24, stand 70.

Circle No 713

Gold-contact pc-board switches provide several switching functions

Models 15.502 and 15.552 are gold-contact versions of the company's momentary and alternate-action silver-contact switches. These low-profile, pc-board-mounting modular switches are suitable for low-voltage and dry-circuit switching, or for applications in which they might be subjected to corrosive environments. Each switch has a contact configuration that allows you to implement a variety of switching functions—including two changeover contacts, two normally open or normally closed contacts, two normally open and two normally closed contacts, or polarity-reversal contacts —simply by altering the pc-board tracking.



The switches' initial contact resistance is 35 mΩ. The switch contacts have a maximum switched current rating of 250 mA, and a maximum voltage rating of 120V. When they are not switching, they can carry a current of 0.5A. Their ac and dc power ratings are 9 and 6W, respectively. Their contact bounce is <5 msec. The switches have an operating pressure of around 2 newtons, and the key travel is 1.8 mm. The momentary-action version of the switch has a lifetime of 1,500,000 switching cycles; the alternate-action version has a lifetime of 500,000 cycles. The switches' operating temperature range is −25 to +75°C.

They have a 12.6-mm square footprint and presoldered leads that fit into pc-board holes on a 0.1-in. matrix. The switches accept a variety of keycaps and bezels, including the company's new Model 16.700 concave keytops. The gold-contact switches cost less than $1.50 (1000).

Mec, Industriparken 23, 2750 Ballerup, Denmark. Phone 02-973366. TLX 9125649. Hall 4, alley 43, stand 97.

Circle No 714

Single-chip token-bus modem supports MAP networks

The SAB82511 baseband modem provides layer-1 functions of the OSI communications model for IEEE-802.4 token-bus networks. It is therefore suitable for use in MAP (manufacturing automation protocol) networks. An associated token-bus controller, the SAB82510, will provide layer-2 functions; it's scheduled for introduction before the end of this year.

Using phase-coherent FSK modulation, the modem transmits data at a rate of 5M or 10M bps. It also includes a digital demodulator to decode received data. The modem chip generates the receive and transmit clocks from a 20-MHz crystal or from an external frequency source, provides station-management functions, and has an electrical interface that you can connect directly to a network-medium coupling transformer.

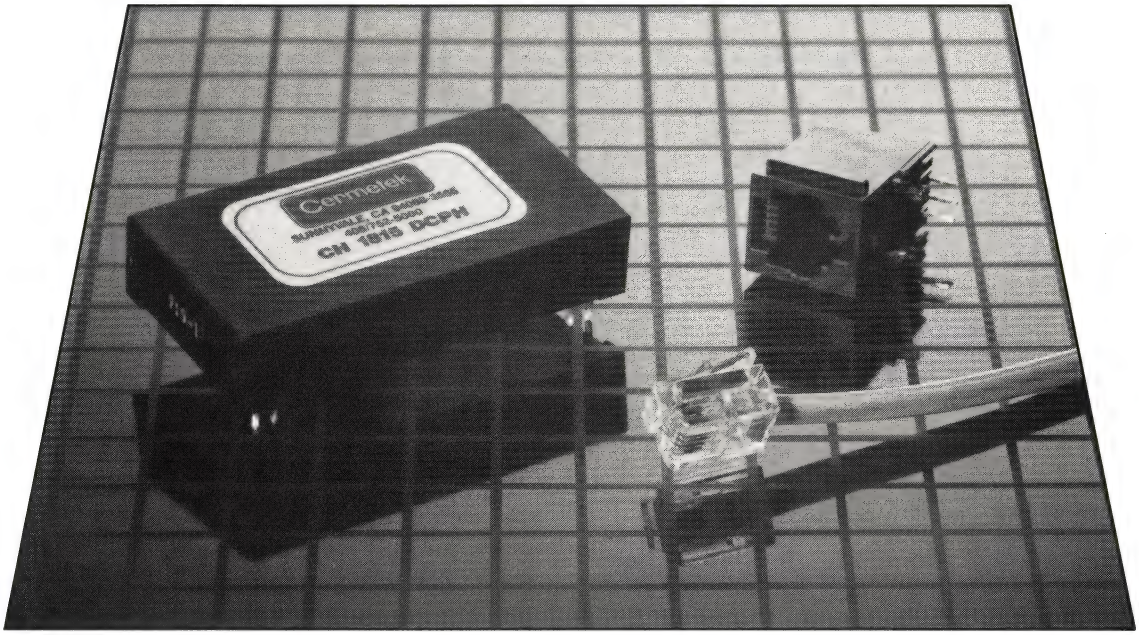
The modem recognizes five distinct transmission states from the media-access control (layer-2) functions of the token-bus controller: silence, nondata, pad-idle, data one, and data zero. It modulates the transmit carrier signal accordingly. It also supports such station-management functions as a loop-back mode for use in fault diagnosis. In addition, the modem incorporates a watchdog timer to prevent the modem from locking up the network by going into continuous-transmit (jabber) mode.

The SAB82511 is packaged in a 44-pin plastic leaded chip carrier and operates over 0 to 70 °C. It uses one 5V supply and draws a maximum supply current of 290 mA. All inputs and outputs that interface the modem to the token-bus controller are TTL-compatible. Approximately $50 (1000).

Siemens AG, Zentralstelle für Information, Postfach 103, 8000 Munich 1, West Germany. Phone (089) 2340. TLX 5210025. Hall 4, alley 43, stand 8.

Circle No 711

PHONE LINE INTERFACES
QUICK-TO-MARKET SOLUTIONS



THE PROBLEM

Products that connect directly to the telephone line must be registered:

☐ FCC in the United States
☐ DOC in Canada
☐ BABT in the United Kingdom
by telephone authority in most other countries

This means first understanding and interpreting local requirements, then conducting tests to meet these requirements and finally obtaining approvals.

Needless to say, this can be an involved and time-consuming process taking as much as 12 months to complete.

THE SOLUTION
Telephone Line Interfaces

Cermetek manufactures a complete line of telephone line interfaces that either eliminate registration process or greatly reduce the risk of delays.

The CH1810A, for example, is already FCC registered and is shipped to you with an FCC registration sticker to place on your equipment.

Other telephone line interfaces are designed for international operation — CH1814/CH1828, ultra small size — CH1815 or high volume/low cost — CH1812A/1813

And all are compatible with today's modem components. Cermetek provides application notes, design assistance and help with registration. Write or call us for more information.

Phone Line Interface Components

Features	CH1810A	CH1811	CH1812A/ CH1813	CH1814	CH1815	CH1828
Countries for use	U.S. Canada	U.S. Canada	U.S. Canada	Inter-nat'l	U.S. Canada	Inter-nat'l British
Pre-Registered	FCC Part 68	FCC Part 68	Conforms FCC	British Pending	Conforms FCC	Regis-tered
Surge and High Voltage Protection	Yes	Yes	Yes	Yes	Yes	Yes
Isolation	1KV	1KV	1KV	1.5KV	1KV	4KV
Ring Detect and ON/OFF Hook Control	Yes	Yes	Yes	Yes	Yes	Yes
Phone Hook Switch Detect	–	–	1813	–	–	–
2- to 4-wire Conversion	Yes	Yes	N0	N0	N0	Yes
Data and voice	Data	Both	Data	Data	Data	Data
Size (in.) L W H	2.2 x 2 x .7	2.2 x 2 x .7	2.1 x 1.1 x .6	2.1 x 1.1 x .6	2.1 x 1.1 x .45	3.4 x 3.4 x .77
Power	+12V 275mW	+5V 100mW	Inter-Face Driven	Inter-Face Driven	Inter-Face Driven	+12V — 700mW

Cermetek
microelectronics

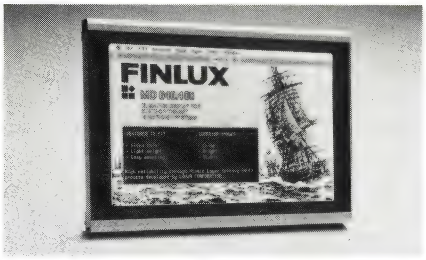
Cermetek Microelectronics, Inc.
1308 Borregas Avenue Sunnyvale, CA 94088
Telephone: 408/752-5000
Fax: 408/752-5004
Twx: 910-379-6931

CIRCLE NO 88

Electroluminescent display provides graphics and 25-line×80-column text

The Finlux MD640.400 flat-panel electroluminescent display has a screen resolution of 640×400 pixels, allowing you to display high-resolution graphics or 25 lines of text at 80 characters/line. The display comes with a display-driver board and power supply and requires only TTL-level video data, video clock, and horizontal and vertical synch-pulse inputs. It's designed to scan at a refresh rate of 60 Hz.

Comprising a matrix of 0.22-mm square pixels on a 0.3-mm pitch (which is equivalent to 83 pixels/in.), the display produces a flicker-free yellow image with a viewing angle of greater than 140°. The pixel luminance is typically 90 cd/m^2. The display area is 122 mm high and 195 mm wide, and the whole display assembly, including the drive-electronics board, measures 158.5 mm high, 228.6 mm wide, and only 18.3 mm deep.



A dc/dc converter, which you can use remotely or mount on the back of the assembly, is supplied with the unit; it's connected to the display via a ribbon cable. The converter requires dc inputs of 12 or 15V and 5V, and the display typically consumes 16W. It operates over 0 to 55°C.

Prototypes of the display are available now; production shipments are scheduled to start during the first quarter of 1988. The initial sample price for the MD640.400 is DM 2710, or $1650.

Lohja Corp, Electronic Display Div, Box 46, 02201 Espoo, Finland. Phone 042001. TLX 125023.

Circle No 709

Finlux Inc, 20395 Pacifica Dr, Suite 109, Cupertino, 95014. Phone (408) 795-1972. Hall 4, alley 45, stand 126.

Circle No 710

ECL gate arrays let you make tradeoffs between speed and power

When you design with the SH100E family of ECL gate arrays, you can select the logic gates to operate at one of three speed/power levels. For designs that require some parts of the logic to run faster than other parts, you can mix these three speed/power levels on a single device, provided that you don't exceed the maximum power-dissipation level of the PGA package.

The standard speed level for a logic gate provides you with a typical gate delay of 130 psec, a delay per unit load of 30 psec, and a delay per millimeter of routing metal of 150 psec. This speed level results in an average power dissipation per gate of 1 mW for a −3.3V supply voltage and 1.5 mW for a −4.5V supply voltage.

Selecting the low-power mode increases the typical gate delay, the delay per unit load, and the delay per millimeter of metal to 220, 60, and 300 psec, respectively, but reduces the average power dissipation per gate to 0.5 mW for a −3.3V supply and 0.75 mW for a −4.5V supply.

Selecting the high-speed mode leaves typical gate delays at 130 psec, but reduces the delay per unit load and the delay per millimeter of metal to 15 and 75 psec, respectively. However, it increases the average power dissipation per gate on −3.3 and −4.5V supplies to 2 and 3 mW, respectively.

The initial offering is a 2500-gate array, but during 1988 the company plans to extend the family to include arrays with gate counts of between 1000 and 10,000. The array's I/O pins are 10K/100K ECL compatible, and on all the arrays except the 10,000-gate version, you can optionally configure the I/O pins to be LSTTL compatible.

A library of ECL and current-mode-logic functions for the product is already available, and the vendor will accept designs for implementation in silicon during the second quarter of 1988. For the 2500-gate array, the company predicts that nonrecurring layout and prototyping charges will be less than DM 100,000, and the per-piece cost will be less than DM 500 (1000).

Siemens AG, Zentralstelle für Information, Postfach 103, 8000 Munich 1, West Germany. Phone (089) 2340. TLX 5210025. Hall 4, alley 43, stand 8.

Circle No 716

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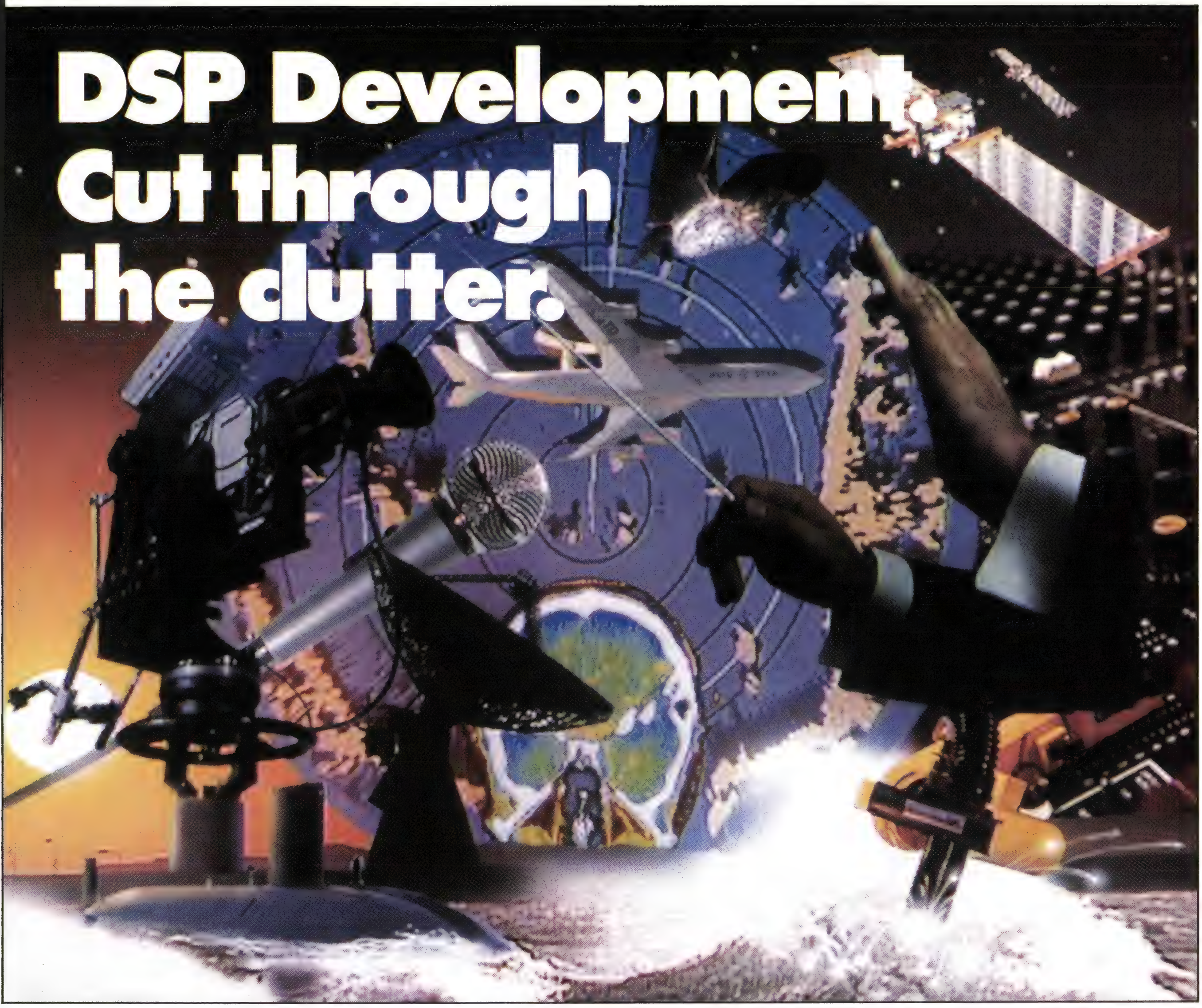

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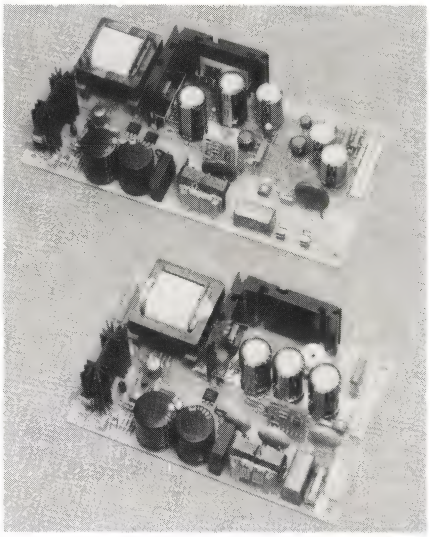
CIRCLE NO 89

Convection-cooled 40 and 60W switch-mode power supplies fit on single Eurocards



The 190 Series 40W and 60W frameless switch-mode power supplies employ 150-kHz self-oscillating flyback-converter technology and achieve an MTBF of 40,000 hours. The 40W range comprises single-output versions with a 5V/6A, 12V/2.5A, or 24V/1.25A output; dual-output versions with a 5V/4A main output and a 12V/2A auxiliary output or with ±12V/1.25A outputs; and triple-output versions with a 5V/5A main output and 12V/2A and −12V/0.5A auxiliary outputs, or with a 5V/4A main output and either ±12V/0.8A or ±15V/0.5A auxiliary outputs.

The 60W range comprises single-output versions with a 5V/12A, 12V/5A, or 24V/2.5A output; dual-output versions with a 5V/8A main output plus a 12V/3A auxiliary output or with ±12V/2.5A outputs; and triple-output versions with a 5V/8A main output and auxiliary outputs of 12V/3A and −12V/1A, or with a 5V/8A main output and ±12V/1A auxiliary outputs.

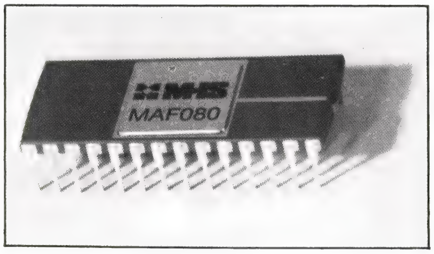
All the main outputs are fully regulated: The line regulation for ±10% line input variations is ±0.2%; the zero- to full-load regulation is ±2%. You can reduce the load regulation to ±0.5% by using the remote-sensing terminals provided on single-output versions of the power supplies. All the main outputs have potentiometer adjustment.

The auxiliary outputs have a line regulation of ±0.5% and a half- to full-load regulation of ±5%. All the outputs have short-circuit protection, and the 5V outputs have overvoltage protection. All the power supplies operate from 90 to 140V (or 180 to 264V), 47- to 63-Hz ac line supplies. The power supplies operate over 0 to 70°C but require linear derating to 50% between 50 and 70°C. $80 to $120.

Philips, Industrial and Electroacoustic Systems Div, 5600 MD Eindhoven, Netherlands. Phone (040) 788620. TLX 35000. Hall 1, alley 17, stand 70.

Circle No 712

Low-cost CMOS gate arrays achieve gate delays as low as 1 nsec



The MAF Series gate arrays are fabricated in 1.2-μm silicon-gate CMOS technology; they achieve typical gate delays of 1 nsec, so they're suitable for use as low-power replacements for bipolar PLDs. Gate complexities range from 250 to 1200 gates. When it's operating from a single 5V supply at a clock speed of 10 MHz, the 1000-gate array typically dissipates 250 mW.

Because the MAF arrays are architecturally the same as the company's MA Series gate arrays, you can use the same design tools and libraries that the vendor supplies for the MA Series. The vendor also offers software that allows you to develop designs on a range of computers and workstations, including the IBM PC, Daisy workstations, and VAX computers.

Packaging options for the arrays include DIPs, surface-mount packages, and pin-grid arrays. The packages can have as few as eight pins or as many as 68. A gate array in a 40-pin plastic DIP costs $2.30 to $4.30 (100), depending on the number of gates.

Matra-Harris Semiconducteurs, Centre de Guyancourt, 38 Blvd Paul Cézanne, BP 309, 78054 Saint-Quentin-Yvelines Cedex, France. Phone 1-30607000. TLX 697317. Hall 3, alley 36, stand 19.

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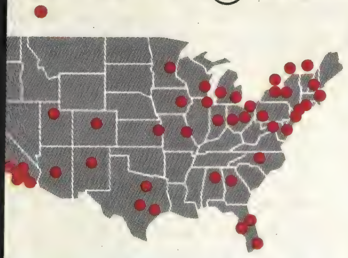

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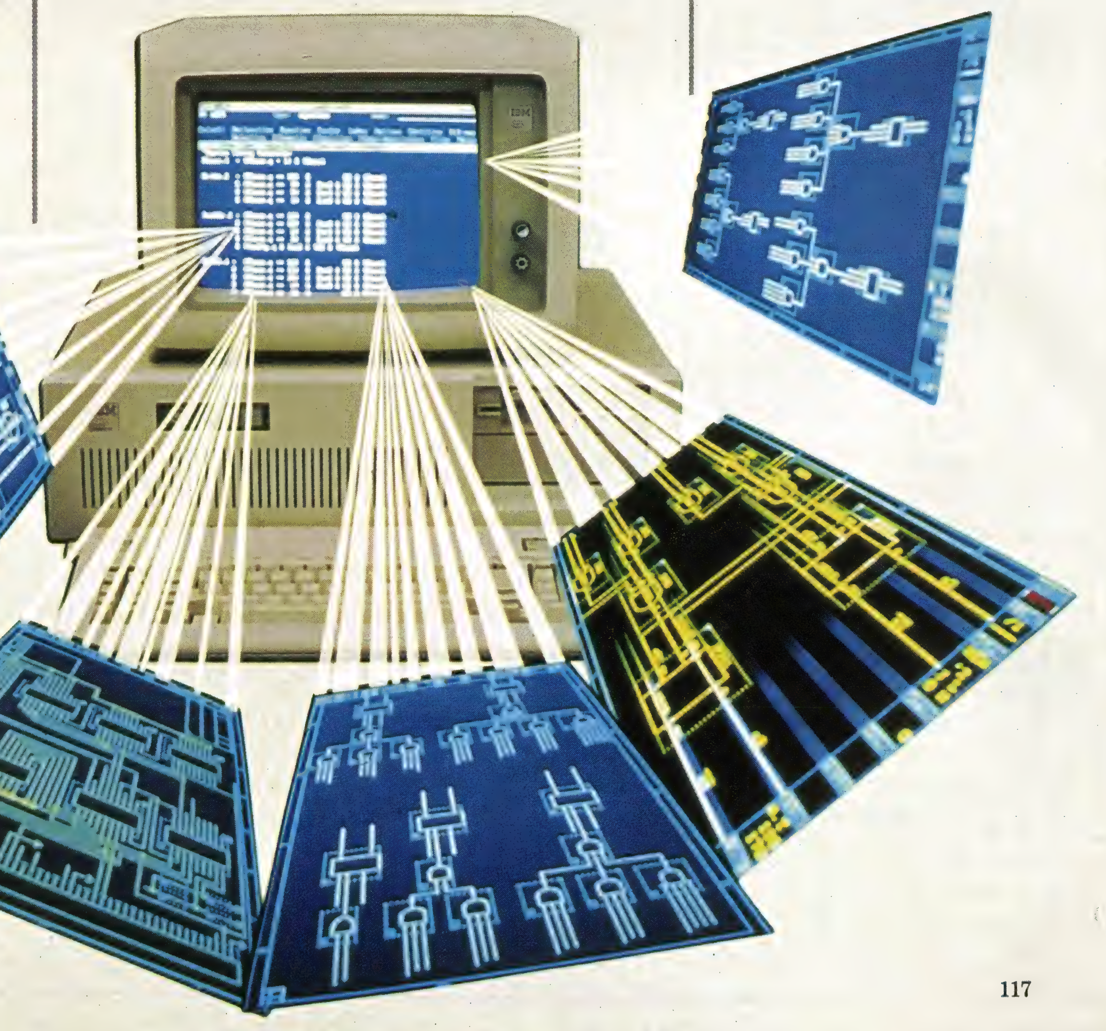

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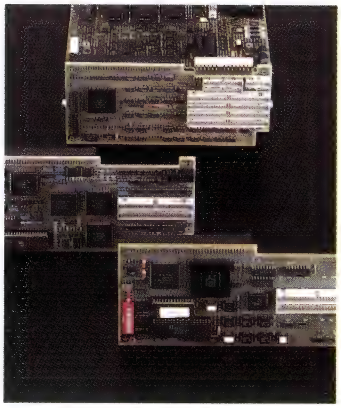

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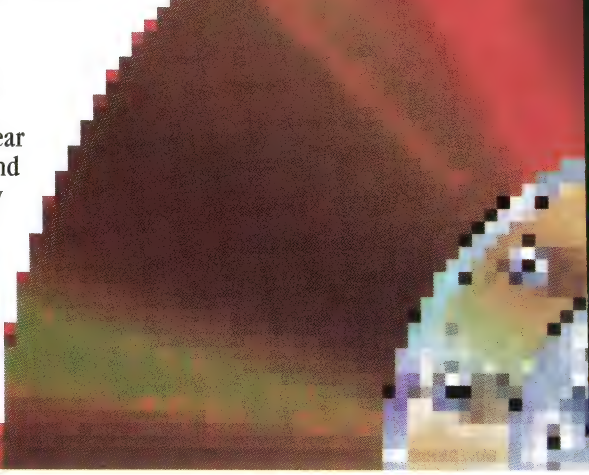

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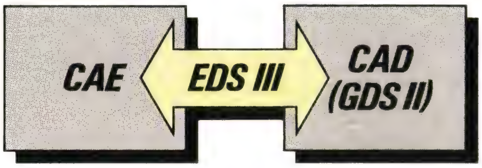

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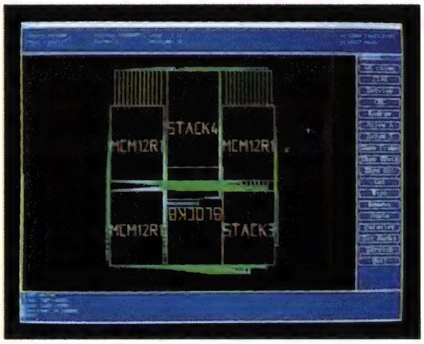

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CIRCLE NO 94

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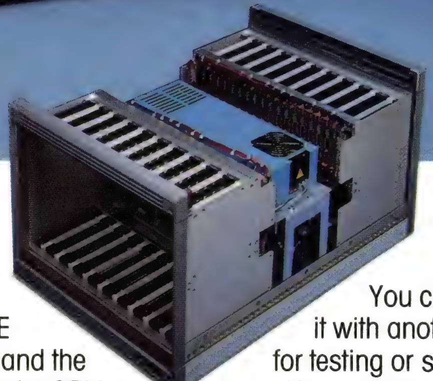

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Registered I/O and enhanced controls make EPLD suitable for μP designs

The 5AC312 is a CMOS, UV-erasable programmable logic device (EPLD) with enhancements to the standard PLD architecture that make it especially suitable for μP applications. The 24-pin PLD runs at 40 MHz with no feedback (25-nsec t_{PD} typ) and consumes 150 μA of standby current. (The programmable, low standby current comes at the price of an additional 10-nsec delay.)

The device has programmable outputs and programmable inputs. The 5AC312's 12 programmable output macrocells are similar in function to those of the industry-standard 22V10 PLD. As **Fig 1** shows, you can program the device's output macrocells to act as D, T, or JK registered outputs; combinational outputs; buried state registers; or inputs. An XOR gate in the signal path allows you to program the output's polarity. Note that because the macrocell has two feedback paths into its AND/OR array, you can use it as an input and a buried state register simultaneously.

More unusual are the device's programmable inputs **(Fig 2)**. You can program each of the eight inputs individually to work as a register, a latch, or a conventional flow-through input. You can clock the latches and registers either with an external pin or from a product term (P term). If you choose the P term for control, the external-control pin can function as an asynchronous input to the AND/OR array. The ability to clock both inputs and outputs separately suits μP applications that employ multiphase clocks.

Further, for μPs with multiple qualifiers, the device has two product terms (instead of the usual single term) for each of its output-macrocell, secondary control signals: output enable, preset, clear, and clock.

Internally, the PLD's AND/OR array has a unique architecture that can permit a higher degree of P-term utilization than is possible with conventional PLDs. Conventional PLDs have a fixed number of AND gates associated with each output's OR gate. The 5AC312 has eight AND gates (or P terms) feeding each output's OR gate **(Fig 1)**; the eight AND gates are divided into two groups of four.

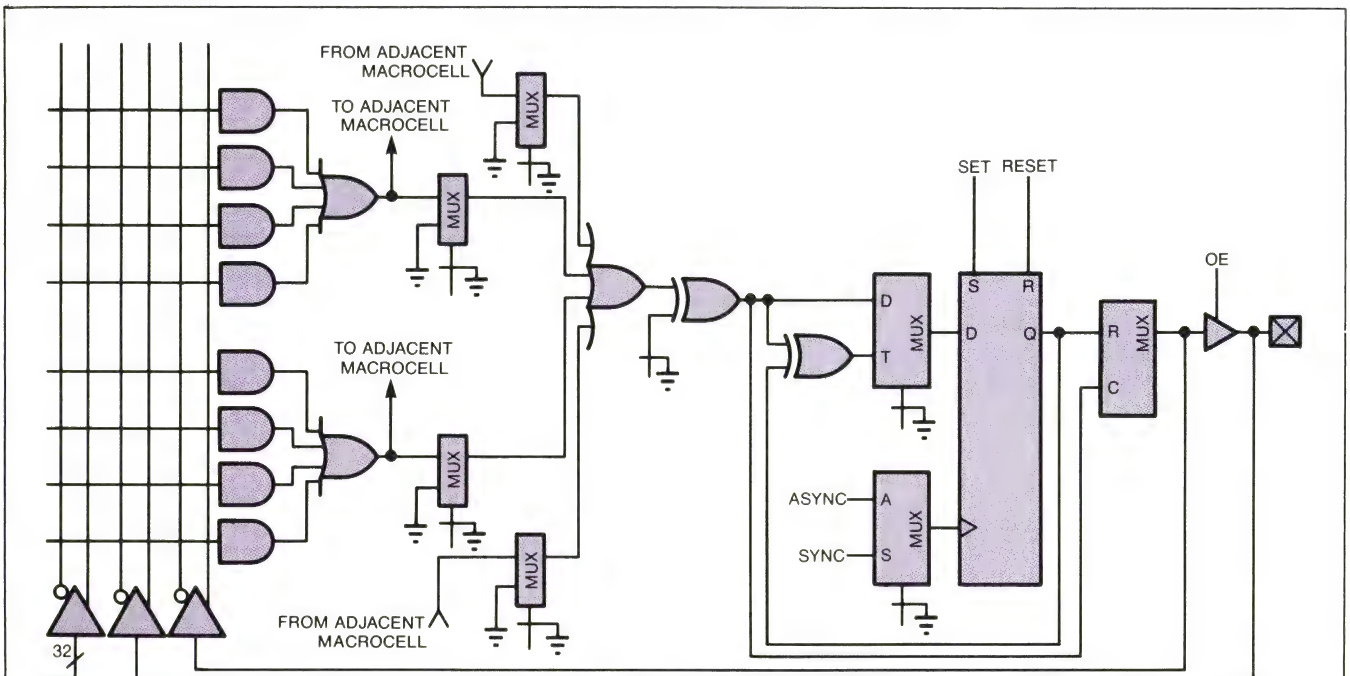

Fig 1—You can program the 5AC312's 12 output macrocells *to act as D, T, or JK registered outputs; combinational outputs; buried state registers; or inputs. The XOR gate in the signal path sets the output's polarity. Note also that you can assign P terms in groups of four (via multiplexers) to either the macrocell or an adjacent macrocell. Not shown in this figure are the two P terms (instead of the usual single P term) that drive the output macrocell's secondary control lines.*

Each group of four first drives its own 4-input OR gate. The outputs of the two OR gates go to a pair of multiplexers. The multiplexers, in turn, feed either their own output macrocell or an adjacent macrocell. Thus, you can assign four, eight, 12, or 16 P terms to a given output macrocell.

The architectural complexity of the 5AC312 taxes the capabilities of PLD software. Currently, only the vendor's iPLDS II version 1.5 software supports the device. The vendor claims that because its UV-erasable CMOS technology is more reliable than bipolar fuse-link technology, and because it programs, tests, and erases each device before shipping, you do not need to perform any testing on devices after you program them at your facility. This purportedly high, no-test AQL (acceptable quality level) stands in sharp contrast to bipolar devices, which require burn-in and testing after programming to achieve a high AQL.

The 5AC312 will be available in sample quantities this quarter; production quantities will be available in the first quarter of 1988. Windowed devices cost $21.50 (100), and production quantities of nonwindowed, one-time-programmable (OTP) devices will be $10; iPLDS II version 1.5 costs $3450.

—*Charles H Small*

Intel Corp, Literature Dept W-388, 3065 Bowers Ave, Santa Clara, CA 95052. Phone local office.

Circle No 722

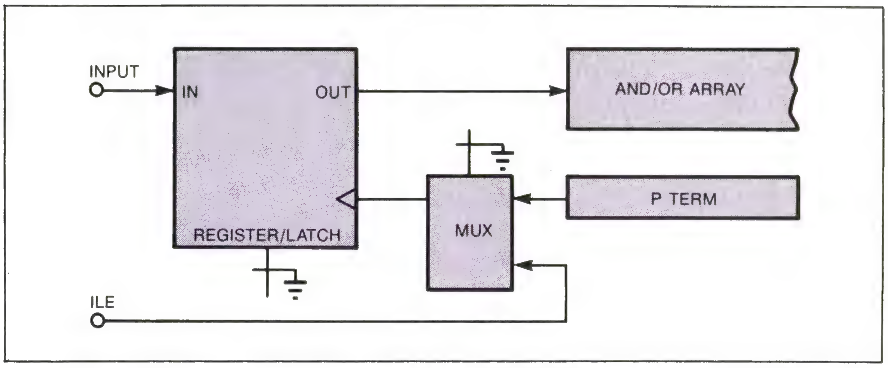

Fig 2—The UV-erasable device's eight inputs *are also programmable. The inputs can function as latched, registered, or standard inputs. You can clock the latched or registered inputs either with an external pin or from a P term.*

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32-BIT	Z80,000		△			ADA
16-BIT	Z8001		X	X	X	ADA
	Z8002		X	X	X	
	Z8005		X			
	Z8030 Z-SCC		X	X		
	Z8530 SCC		X	X		
	Z8036 Z-C10		X	X		
	Z8536 C10		X	X		
	Z8581 CGC		X	X		
	Z8038 FI0		X			
8-BIT	Z280		△			C
	Z180		△			
	Z80		X	△	X	
	Z8420 PIO		X	X		
	Z8430 CTC		X	X		
	Z8440 SIO		X	△		
	Z8441 SIO		X	△		
	Z8442 SIO		X	X		
	Z8444 SIO		X	△		
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CIRCLE NO 96

Five-chip set eases design of 100M-bps, fiber-optic local-area networks

The Supernet 5-chip set is compatible with ANSI X3T9.5, which is also known as the Fiber Distributed Data Interface (FDDI) standard. FDDI allows as many as 500 network nodes to transfer data at 100M bps. The distance between nodes can be 2 km, and the total fiber length can be as great as 100 km.

FDDI is organized as a dual ring of optical fiber—a primary ring and a secondary ring. The rings consist of a series of point-to-point connections between neighboring nodes. If a station or a link fails, the secondary ring can act as a backup ring.

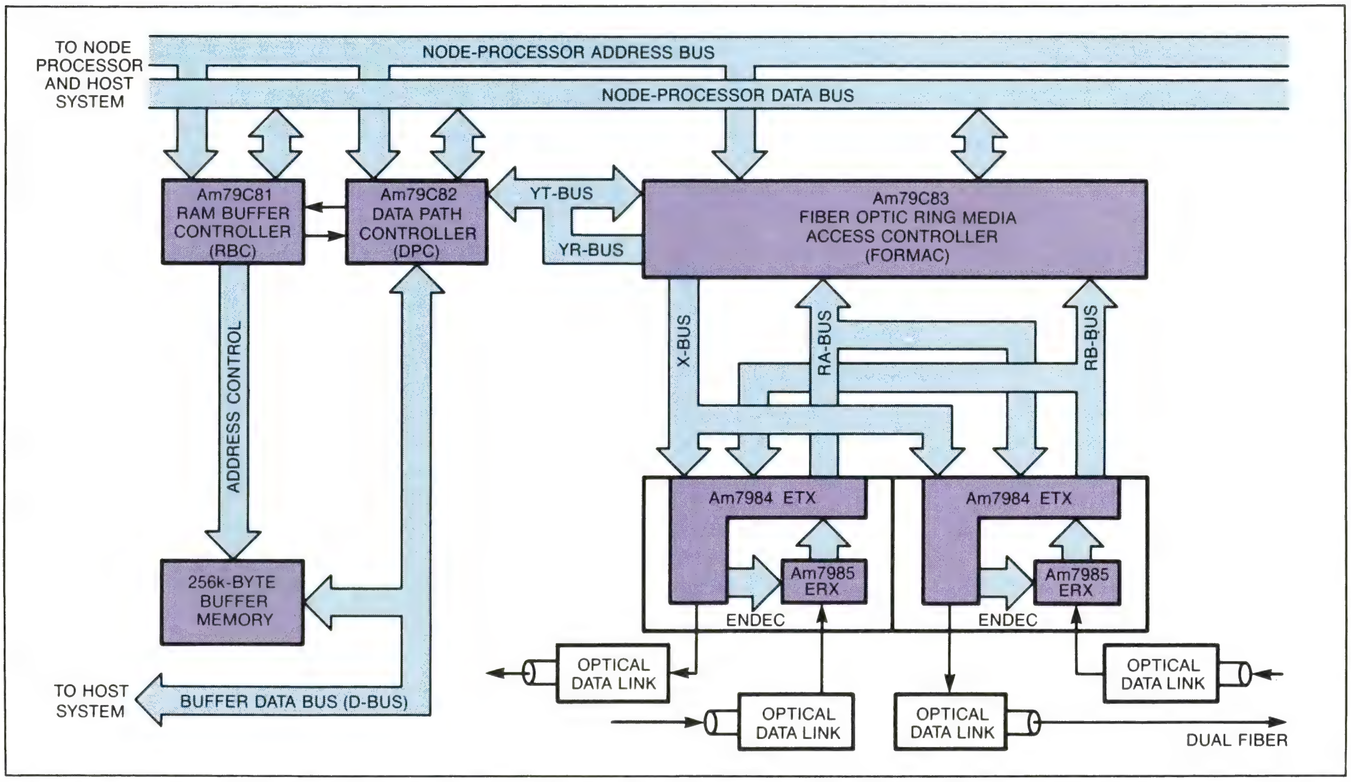
FDDI uses a timed token-ring protocol. The ring's maximum token-rotation time is decided in a bidding process that takes place at initialization. The bidding process allows the station that requires the fastest time between token arrivals to dictate the token-rotation time for the ring; the process also guarantees each node access to the network.

The Supernet chip set acts as the interface between a host computer that transfers data in parallel and the network, which transfers data serially. The set consists of the Am7985 Endec Receiver (ERX), the Am79C83 Fiber Optic Ring Media Access Controller (Formac), the Am79C82 Data Path Controller (DPC), the Am79C81 RAM Buffer Controller (RBC), and the Am7984 Endec Transmitter (ETX).

The chip set receives data from the network via the optical data link **(Fig 1)**. The ERX passes the reconstructed 8-bit byte to the Formac. The Formac strips away the packet-format information and sends the pure data to the DPC. The primary function of the DPC is to convert data in received packets from byte-wide to 32-bit-word formats, and to convert data in transmitted packets from 32-bit-word to byte-wide formats.

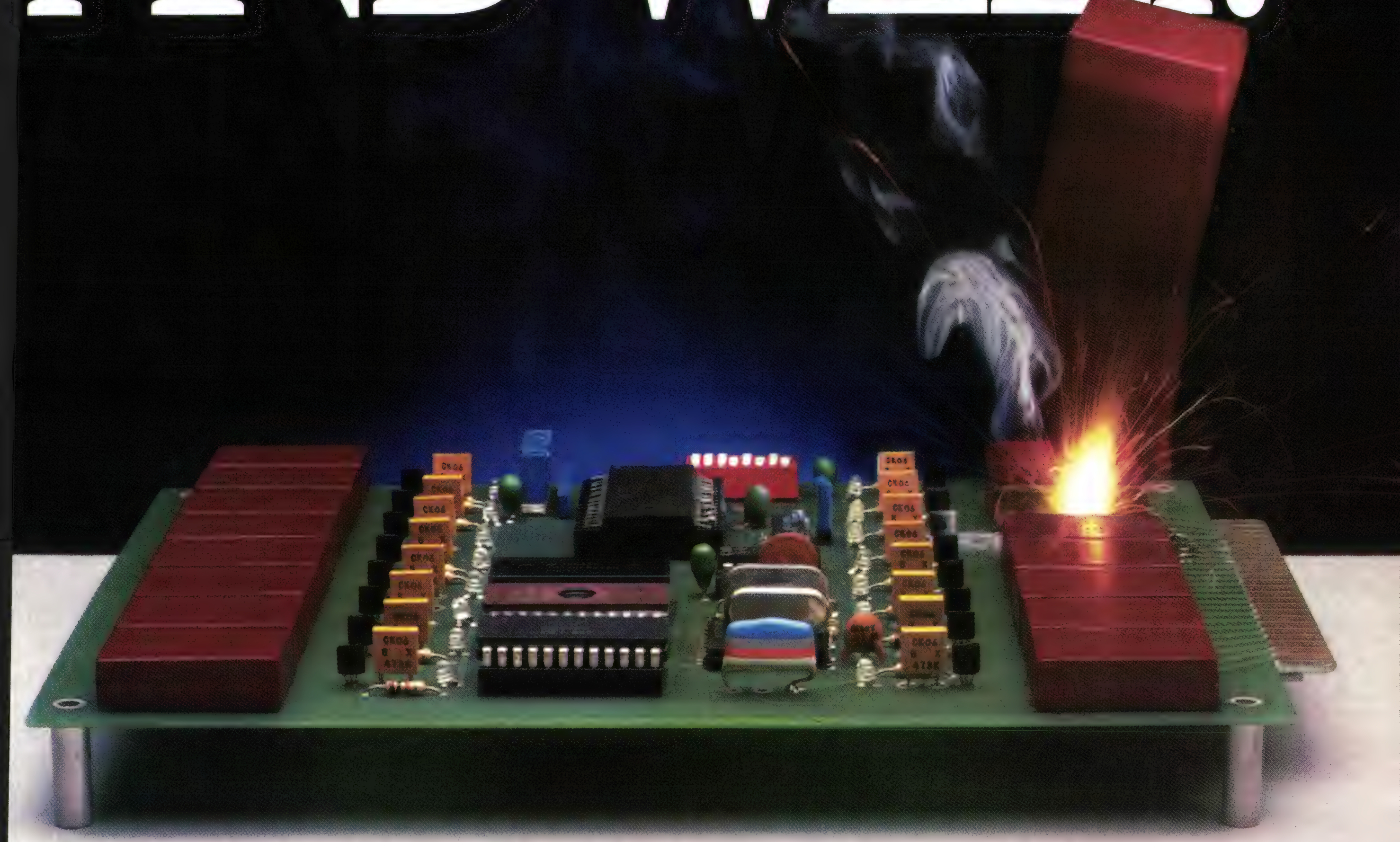
The received 32-bit data is then stored in the buffer memory by the RBC. The data is finally sent to the host processor on a 32-bit bus. The chip expects that the host processor is 32 bits wide; if it's not, you can use external logic to interface the chip set to other bus widths.

When the host processor transmits data to the network via the chip set, the data flows in the oppo-



A 5-chip set *called Supernet acts as the interface between a host computer that transfers data in parallel and an FDDI network, which transfers data serially.*

REED IT AND WEEP.



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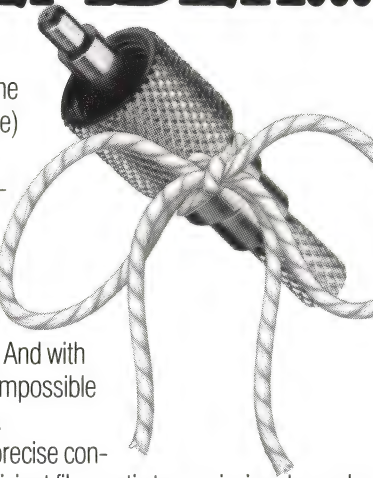
CIRCLE NO 118



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CIRCLE NO 13

site direction—the ETX sends the data to the optical data link.

The Formac performs the Media Access Control (MAC) layer protocol for the FDDI standard. The Formac determines when a node can have access to the network and implements the logic required for token handling, address recognition, and CRC (cyclical redundancy checking).

The RBC generates addresses to the buffer memory for received and transmitted packets. The RBC also arbitrates requests for access to the buffer memory that come from the DPC, the node processor, and the host processor.

The node processor oversees the operation of the chip set. Its main function is to initialize the five chips and respond to various system-level and packet-level interrupts. The node processor and the host processor can be one and the same. In a large system, a powerful and independent node processor can be used to offload various network-specific chores.

The vendor plans to offer an implementation of its Station Management software-development package for the Supernet chip set. Station Management is a network-management package that controls the operation of the physical and data-link components. The development package will be available in the first quarter of 1988. Samples of the 5-chip set are available now. A limited number of production parts are also available; they sell for $625 (100). The chip set will be in full production in the first quarter of 1988.—***David Shear***

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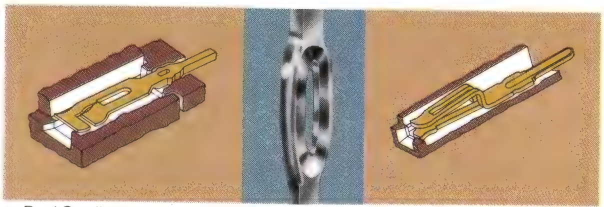

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CIRCLE NO 120

VME Bus-based system uses the 32200 μP, runs Unix System V release 3.1

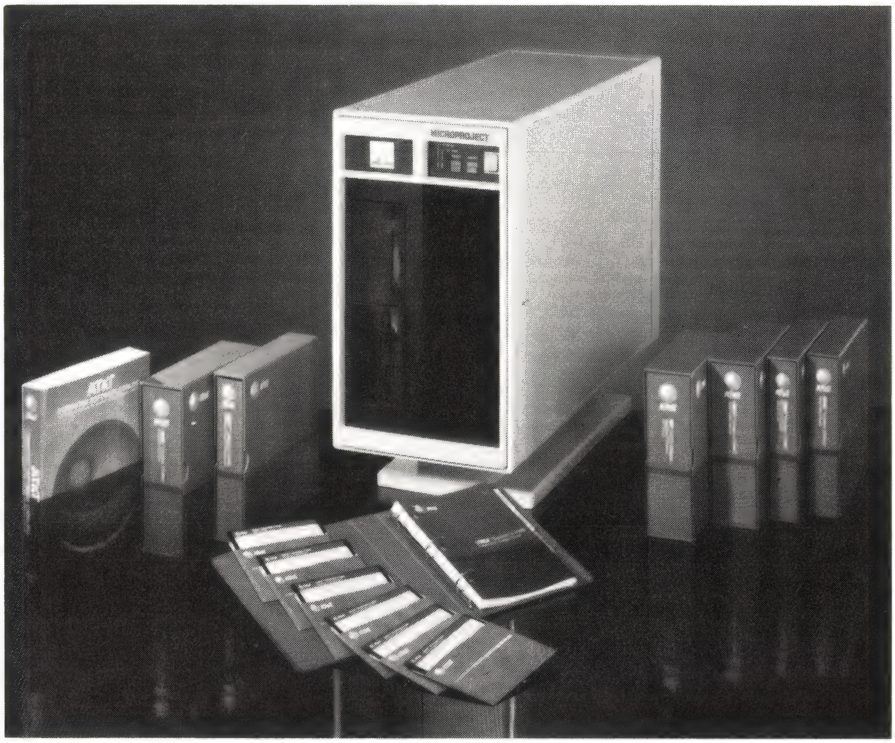
The Unicorn C multiuser/multitasking computer system runs Unix System V release 3.1. The VME Bus-based system incorporates the AT&T WE 32200 μP and support chips. You can buy configurations of the system that support as many as 200 users and a variety of peripheral configurations. In addition, the Unix implementation provides software hooks that let you easily add device drivers without modifying the Unix source code.

Unix System V release 3.1 includes several features not found in earlier versions of the operating system. For example, the new release allows systems on a network to share files and executable libraries. In addition, release 3.1 includes a streams-communication interface.

The CPU chip set used by the system includes a 30-MHz WE 32200 μP, a WE 32201 MMU/cache, a WE 32104 32-bit DMA controller, and a WE 32106 math coprocessor. The DMA/cache chip allows the μP to access local dynamic RAM with zero wait states. When you boot the system, the system software loads frequently used portions of the Unix kernel into the local memory, thereby speeding execution of the operating system.

A host adapter provides an intelligent SCSI (Small Computer System Interface) bus that handles input and output independently of the system bus. The SCSI bus can connect to disk and tape drives, as well as to other peripherals.

You can buy system configurations with hard-disk drives ranging in capacity from 40M to 780M bytes. You can also choose from cartridge or 9-track open-reel tape drives. The system includes an Ethernet interface.



The VME Bus-based *Unicorn C computer system runs Unix System V release 3.1, which includes such enhancements as network file sharing and executable libraries.*

Because the system uses the AT&T chip set and runs Unix System V, it can execute any code developed for AT&T's 3B computer family, which runs more than 1000 software packages for engineering and business applications. In addition, any updates that AT&T makes to Unix will be immediately available for the Unicorn C.

You can also specify the system with 68000-family VME Bus boards that act as a front end for real-time control applications. The company offers several real-time operating systems—including Software Components Group's pSOS, Industrial Programming's MTOS, and Ready Systems' VRTX—to control the VME Bus boards. You can also add interface modules, such as an IEEE-488 interface, to the boards.

The Unicorn C is available in versions having 5-, 12-, and 21-slot VME Bus backplanes. The cost of the system ranges from $15,000 for an 8-user, 85M-byte configuration to $40,000 for a 380M-byte version that supports 64 users.

—*Maury Wright*

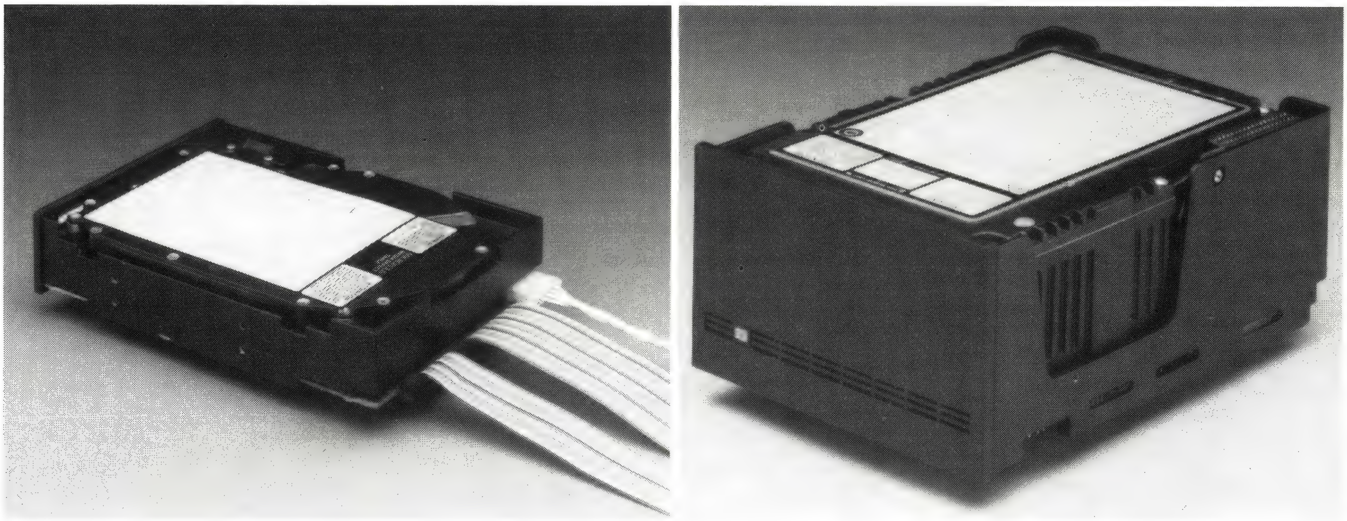
Microproject Corp, 4676 Admiralty Way, Suite 610, Marina del Rey, CA 90292. Phone (213) 306-8000. TLX 556443.

Circle No 725

Microproject BV, Claus Sluterweg 125, 2012 WS Haarlem, The Netherlands. Phone 23-292084. TLX 71189.

Circle No 726

Half- and full-height 5¼-in. drives store 180M and 765M bytes, respectively



Respective data densities as high as 22M and 44M bits/in.^{2} *allow the half-height 1600-family drives (left) to store as much as 180M bytes and the full-height 1500-family drives (right) to store as much as 765M bytes. You can choose SCSI or ESDI interfaces for both drive sizes.*

The half-height 1600 family and the full-height 1500 family of 5¼-in. Winchester disk drives offer storage capacities of 180M and 765M bytes, respectively. Both drive families offer ESDI (Enhanced Small Device Interface) and embedded-SCSI (Small Computer System Interface) models. Furthermore, both families feature a straight-arm, 1-piece rotary voice-coil actuator that gives the drives typical seek times of 16 msec.

The 1650/1670 (ESDI/SCSI) half-height drives employ four platters to achieve the 180M-byte unformatted capacity. The drives store data on seven of the disk surfaces; the remaining surface is dedicated to servo-control functions. Because each drive uses 2,7 RLL encoding, is partitioned into 1249 cylinders, and writes 20,832 bytes/track, it has a data density of 22M bits/in^2.

Eight platters fit within the full-height package of the Model 1560/1580 (ESDI/SCSI) drives. The drives store data on 15 disk surfaces and use one surface for servo control. Each drive is partitioned into 1632 cylinders and writes 31,248 bytes/track, so it has a data density of 44M bits/in^2.

The 1650/1670 drives' read channels operate at 10 MHz, and the 1650 also performs 10M-bps transfers to an ESDI controller. The 765M-byte 1560 ESDI drive can transfer ESDI data at 15M bps. In fact, both the 1560 and the 1580 drives have read channels that operate at 15 MHz.

Both the 1670 and the 1580 share the same embedded-SCSI controller design. The controller implements the CCS (Common Command Set), and it's compatible with all the vendor's SCSI implementations. The controller board includes a 60k-byte buffer, and it can perform read-ahead caching operations. It decodes SCSI commands from a host in less than 750 μsec.

Although the drives' read-channel electronics can't operate at such speeds, the controller can transfer data at the specified SCSI rates of 1.5M bytes/sec asynchronously and 4M bytes/sec synchronously. The vendor claims the controller has been tested at higher speeds in the lab.

The vendor specifies an MTBF of 35,000 hours for the 1600 family and 30,000 hours for the 1500 family. Samples of both product families are available now; production quantities will be available in the second quarter of 1988. The Model 1600 drives cost less than $4.50/megabyte (2500); the Model 1500 versions are less than $3/megabyte (2500).

—Maury Wright

Micropolis Corp, 21123 Nordhoff St, Chatsworth, CA 91311. Phone (818) 709-3306. TLX 651486.

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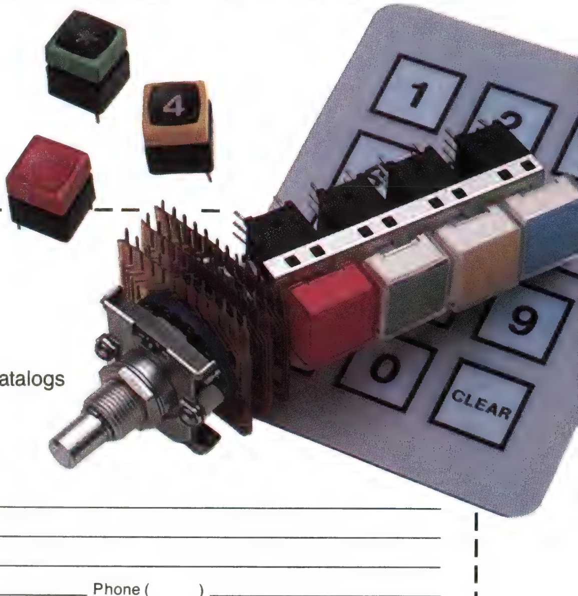

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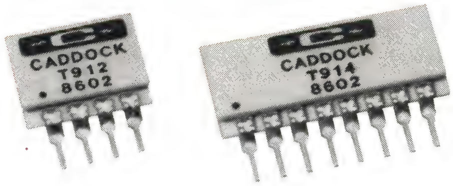

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Standard models of the Type T912/T914 Precision and Ultra-Precision Resistor Networks combine all of these performance characteristics:

- **Absolute Tolerance:** 0.1% for all resistors.
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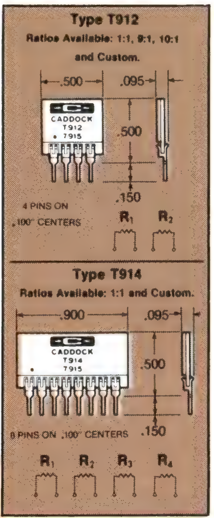
- **Ratio Temperature Coefficients:** from 10 PPM/°C to 2 PPM/°C.
- **Absolute Temperature Coefficient:** 25 PPM/°C from 0°C to +70°C.
- **Ratio Stability of Resistance at Full Load for 2000 Hours:** within 0.01%.
- **Shelf Life Stability of Ratio for Six Months:** within 0.005%.

The standard part number below provides a selection of over 500 in-production models of Type T912/T914 precision and ultra-precision 'pairs' and 'quads':



T912 - A 10K - 010 - 10

Model Number:

Ratio Code Letter:

A - T912 with $R_2 = 10R_1$ (Example: 1K - 10K)
B - T912 with $R_2 = 9R_1$ (Example: 1K - 9K)
No Letter - T912 with $R_2 = R_1$
No Letter - T914 with $R_1 = R_2 = R_3 = R_4$

Standard Resistance Values (R_1):

1K	10K	40K	200K	500K
2K	20K	50K	250K	1 Meg.
5K	25K	100K	400K	

Ratio Tolerance:

-100 = 0.1% -020 = 0.02%
-050 = 0.05% -010 = 0.01%

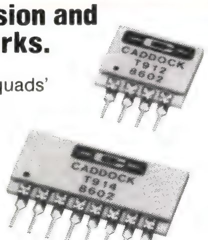
Ratio Temperature Track: (0°C to +70°C)

-10 = 10PPM/°C -05 = 5PPM/°C
-02 = 2PPM/°C

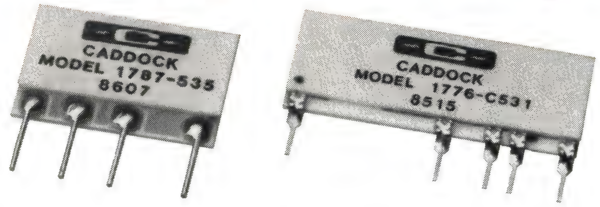
Custom Type T912 and T914 Precision and Ultra-Precision Resistor Networks.

Custom models of these precision 'pairs' and 'quads' can include these special performance features:

- **Resistance Values:** from 1K to 2 Megohms with maximum ratios of 250-to-1.
- **Absolute TC:** as low as 15 PPM/°C.
- **Ratio TC:** as low as 2 PPM/°C.

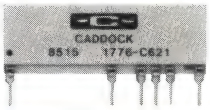


- **For Type T912/T914 data, circle Number 201.**

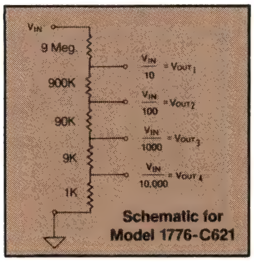


Precision Decade Resistor Voltage Dividers and Current Shunt Resistor Networks deliver many optimum combinations of precision and temperature coefficient performance for high accuracy range-switching circuitry.

Standard Type 1776 Precision Decade Resistor Voltage Divider Networks.



The Type 1776 Precision Decade Resistor Voltage Dividers provide a family of networks that includes 3, 4 and 5-decade voltage dividers with ratios from 10:1 to 10,000:1. Standard performance includes a wide range of specifications in particular combinations that meet the most often requested requirements.


V_{IN}
9 Meg.
900K
90K
9K
1K
$\frac{V_{IN}}{10} = V_{OUT_1}$
$\frac{V_{IN}}{100} = V_{OUT_2}$
$\frac{V_{IN}}{1000} = V_{OUT_3}$
$\frac{V_{IN}}{10{,}000} = V_{OUT_4}$

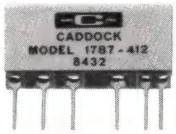
Schematic for Model 1776-C621

- **Absolute Tolerances:** from 0.25% to 0.1%.
- **Ratio Tolerances:** 0.25%, 0.1% or 0.05%.
- **Absolute TC:** from 50 PPM/°C to 25 PPM/°C.
- **Ratio TC:** from 50 PPM/°C to 5 PPM/°C.
- **Voltage Coefficient:** As low as 0.02 PPM/Volt.

With 36 standard models to choose from, each circuit designer can specify the exact levels of performance required by each application.

- **For Type 1776 data, circle Number 202.**

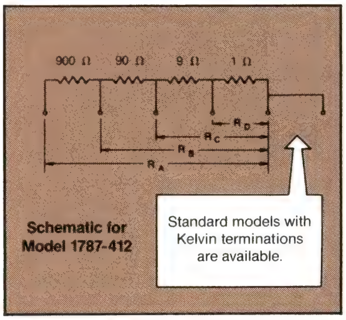
Standard Type 1787 Precision Current Shunt Resistor Networks.



The Type 1787 Current Shunt Resistor Networks achieve the combination of performance requirements necessary to meet the demands of precision current measurement circuits, including laboratory and bench-type instrumentation:

- **Resistance Values:** 1 ohm, 10 ohms, 100 ohms and 1000 ohms.
- **Absolute Tolerances:** 0.25%, 0.1% or 0.05%.
- **Absolute TCs:** 100 PPM/°C, 80 PPM/°C or 50 PPM/°C.

There are now 12 standard models of the Type 1787 Current Shunt Resistor Networks available for 3 and 4-decade applications, and prototype quantities of many models are normally available from factory stock.



Schematic for Model 1787-412

Standard models with Kelvin terminations are available.

- **For Type 1787 data, circle Number 203.**

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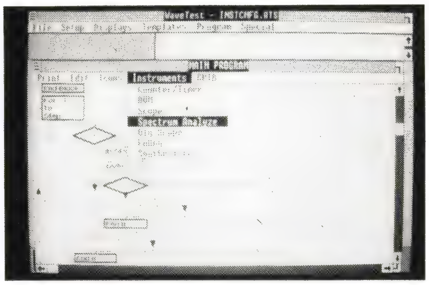
HIGH PERFORMANCE FILM RESISTORS

CIRCLE NO 71

Card and software make PC/AT an instrument controller



The menu selections and flowchart format *provided by the Wavetest software minimize the time you need to program an instrument for test.*

Combined with software, the Wavetest IEEE-488 interface card can turn an IBM PC/AT or compatible computer into an instrument controller. Although this hardware/software instrument-controller package isn't the first one available for the PC/AT, it's particularly easy to use because of its instrument library and menus. You don't need to be an expert in IEEE-488 communications to use this software, you just have to be sure that each instrument has a unique address; the instrument library takes care of the communication.

When using Wavetest, you develop a program from menus in flowchart form. The vendor implements the menus by using Microsoft's Windows program, which is part of the package. In a typical program, you'd select the instruments you want to use; initialize them; step through a set of parameters, taking data at each step; perform some mathematical reduction of the data; and display the data in tabular form.

If you've selected instruments from the library (which contains more than 100 instruments), the menus will guide you through the initialization selections. The menus act as check lists that let you make sure that all parameters are set as you desire. For example, when you want to step through a set of parameters, you first select an instrument. A menu appears to show the parameters that you can vary on that particular instrument. You select the parameter to be varied, the value to start with, and either the step size and final value or the final value and number of steps. You measure a value in a similar fashion—you first select the instrument and then select the function you want to measure.

You can display results directly in tabular form or set up a data-reduction program by using a Basic language block. Wavetest allows you to write any or all of a test program in Basic; however, you'd probably need this function only for data reduction.

You can also select interactive windows that give you direct control of an instrument without executing a program. This feature lets you vary instrument settings during program development and debugging.

The package also allows you to add an operator window to a program; the window prompts you for the necessary input selections before the program runs. Although you could use a PC/XT or compatible machine to run the programs, you need a PC/AT during program development to allow Microsoft Windows to operate at an acceptable speed.

If you need to use an instrument that isn't included in the library, you can add the instrument by means of the package's library-generation program. Wavetest costs $3500.

—Doug Conner

Wavetek San Diego Inc, 9045 Balboa Ave, San Diego, CA 92123. Phone (619) 565-9234. TLX 5212996.

Circle No 727

Your Custom Precision and Ultra-Precision Resistor Networks from Caddock:

- **Can be delivered in only 6 weeks ARO**
- **With total NRE charges typically under $950⁰⁰**
- **Includes 10 prototype networks for your in-circuit evaluation.**
- **Thin-Profile, Single-In-Line package design.**

MODEL T1794-79 8139
Differential Amplifier Input Networks

Type T1794 Custom Low TC Precision and Ultra-Precision SIP Resistor Networks.

T1794-16 8136 3080797 19647
Gain Setting Networks

Caddock's **Tetrinox®** resistance films provide a wide choice of **Absolute TCs, Ratio TCs** and **precision tolerance** specifications. Select the performance of your custom network from the following:

- **Resistance Values:** from 500 ohms to 50 Megs.
- **Absolute Tolerances:** 1.0%, 0.50%, 0.25%, 0.20%, 0.10%, 0.05% and 0.025%.
- **Ratio Tolerances:** 1.0%, 0.50%, 0.25%, 0.20%, 0.10%, 0.05% and 0.025%.
- **Absolute Temperature Coefficients:** 50 PPM/°C, 25 PPM/°C and 15 PPM/°C from 0°C to +70°C.
- **Ratio Temperature Coefficients:** 50 PPM/°C, 25 PPM/°C, 10 PPM/°C and 5 PPM/°C from 0°C to +70°C.
- **For Type T1794 information, circle Number 204.**

Type 1789 Custom Low Resistance Value Precision SIP Resistor Networks.

1789-21 8512
Current-Sensing Networks

Using Caddock's **Micronox®** resistance films, your **low resistance** custom networks can now include:

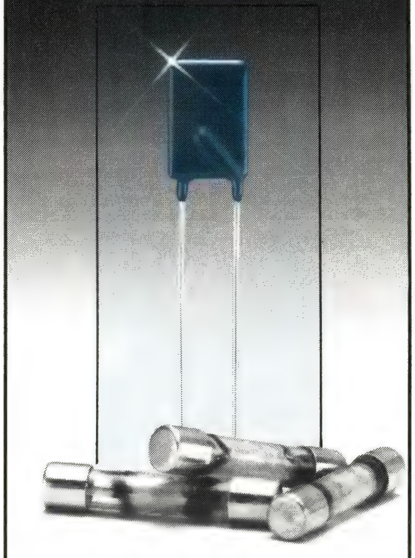
- **Resistance Values:** from 0.5 ohms to 10,000 ohms.
- **Absolute Tolerances:** 1.0%, 0.50%, 0.25%, 0.20%, 0.10% and 0.05%.
- **Ratio Tolerances:** 1.0%, 0.50%, 0.25%, 0.20%, 0.10% and 0.05%.
- **Absolute Temperature Coefficients:** 100 PPM/°C, 80 PPM/°C and 50 PPM/°C from 0°C to +70°C.
- **Ratio Temperature Coefficients:** 80 PPM/°C, 50 PPM/°C, 25 PPM/°C and 15 PPM/°C from 0°C to +70°C.
- **For Type 1789 information, circle Number 205.**

Caddock's high thru-put manufacturing capabilities provide cost-effective, on-time delivery of your custom resistor network requirements. Custom network designs are now in-production in quantities from 500 networks per year to as high as 500,000 networks per year.

For fast solutions to your custom resistor network needs, call our Applications Engineers at Telephone No. (714) 788-1700.

CADDOCK
HIGH PERFORMANCE FILM RESISTORS

CIRCLE NO 14



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Our new Poly Fuse guards against over-current conditions by switching from low resistance to high resistance when its rated current is exceeded. When power is removed, it automatically returns to its low resistance state. This cost-cutting, fool proof, self-restoring component is ideal in applications of 40 volts or less, including motors, solenoids, speakers, alarm systems, battery chargers, communication lines. . . anywhere older technologies are used now.

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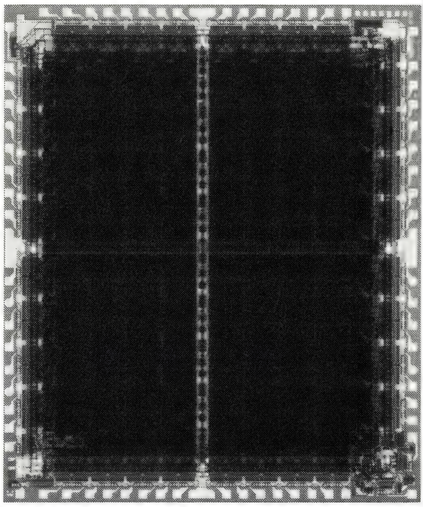
CIRCLE NO 15

Programmable gate arrays have 9000-gate capacity

The XC3000 Logic Cell Arrays are similar to conventional gate arrays except that they're user programmable; they provide 2000 (XC3020) to 9000 (XC3090) gates for logic design. The manufacturer claims that the devices' gate-array-like architecture—unlike the more restrictive AND/OR plane architecture that most programmable logic devices (PLDs) use—lets you achieve the same level of gate utilization that you can achieve with conventional gate arrays. The parts' 1.2-μm, double-layer-metal CMOS process provides a 30-MHz clock rate, which is a level of circuit performance equivalent to that of most CMOS gate arrays. The company projects that by next year its 1.0-μm process will bring the clock rate to 40 MHz and gate count to 12,000.



The XC3020 user-programmable gate array employs 1.2-μm, double-layer-metal CMOS technology *to provide you with 2000 gate equivalents. The part features the same level of utilization typical of conventional gate arrays. In contrast, PLDs based on an AND/OR plane architecture generally can't match the utilization levels of gate arrays.*

Design support for the XC3000 Series comes in the form of schematic-entry packages: FutureNet's Dash and Schema II currently support the arrays. Packages from Daisy, Mentor, Valid, Cadnetix, Personal CAD Systems, Case, Viewlogic, and OrCAD will support the series by the end of the year. Because the arrays are user programmable, they require no NRE charge, no test-tape development, and no revision charges.

The top-of-the-line XC3090 part offers 640 user-definable logic functions and 928 flip-flops—the equivalent of 9000 2-input NAND gates. The XC3020 provides 128 functions, 256 flip-flops, and 2000 gates.

In addition to the top and bottom of the line, you have several other Logic Cell Arrays to choose from. The XC3030 offers 3000 gates, 200 functions, and 360 flip-flops. The XC3042 provides 288 functions, 480 flip-flops, and 4200 gates. Finally, the XC3064 offers 448 functions, 688 flip-flops, and 6400 gates.

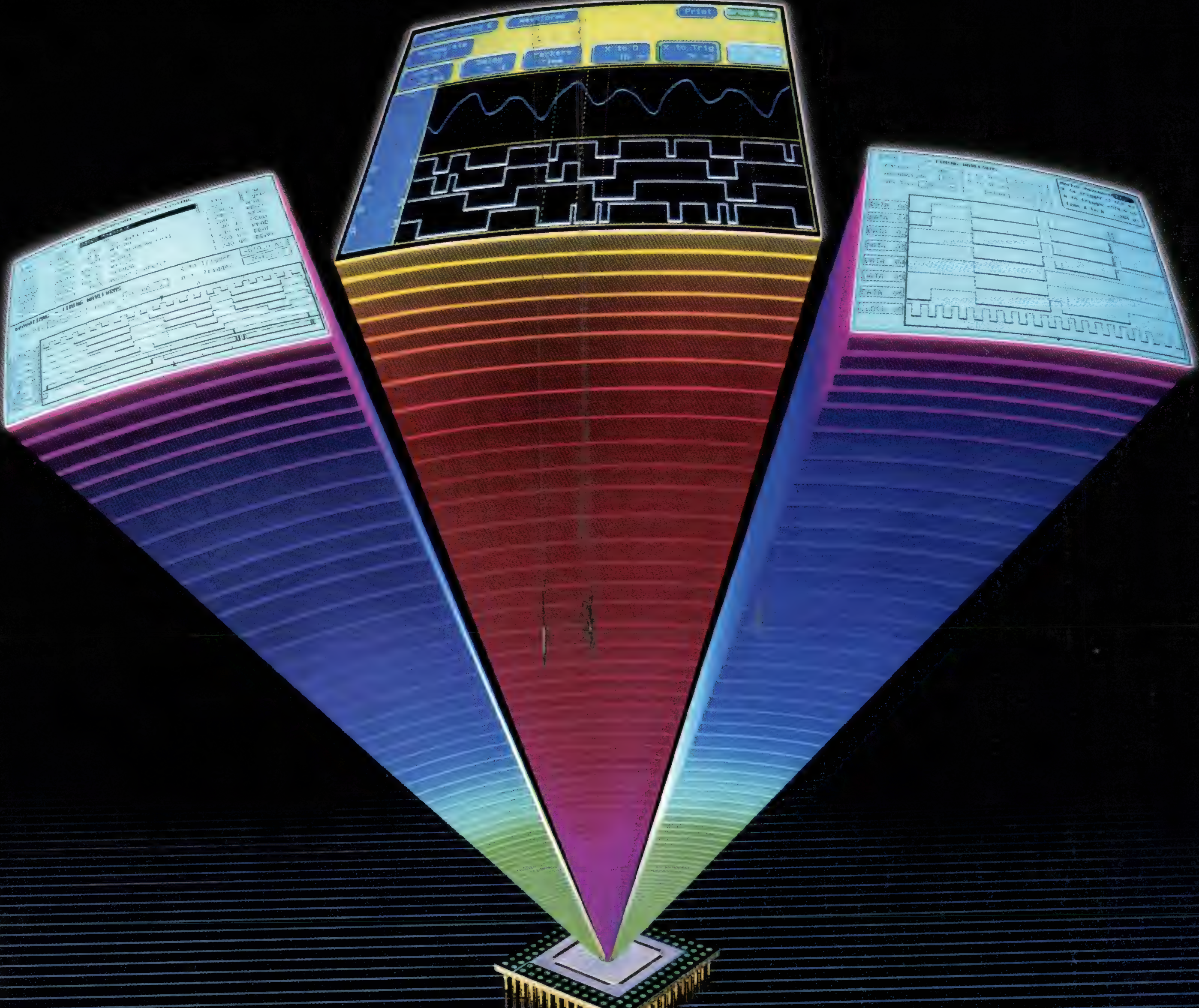
Samples of the XC3020 are available now; samples of the XC3090 will be available in December. High-volume prices start at $20 per device for the XC3020.

—Jim Wiegand

Xilinx Inc, 2069 Hamilton Ave, San Jose, CA 95125. Phone (408) 559-7778. TWX 510-600-8750.

Circle No 721

Hewlett-Packard's new logic analyzer family offers you something not found in other logic analyzers...



HP's new logic analyzer family gives you more of what you want in logic analyzers. For less.

So now measurements are easier to make. And high-quality HP logic analyzers are easier to buy!

You get the performance that best suits you: from 32 to 400 channels of 100 MHz transitional timing/25 MHz state, and up to 80 channels of 1 GHz timing analysis.

Our new family also offers you easy operation, powerful triggering, a CAE link, an oscilloscope, pattern generation, portability, built-in mass storage, simple probing, optional 3-year protection, and much more.

The small secret behind the big value.

To give you more for your money, HP developed a Logic-Analyzer-on-a-Chip containing a complete state analyzer, timing analyzer, and acquisition memory. This proprietary HP IC makes exceptional value possible...80 channels of 100 MHz transitional timing for only $7,800*.

You can assign state or timing in 16-channel increments. Get fully independent state, timing, state/timing, or state/state setups. Even time-correlate measurements on complex multiprocessor systems.

Operational simplicity runs in the family.

We've made our controls even easier than before, without sacrificing performance.

You can make timing or state measurements using just three menus, so you never get lost. Triggering setups, from the simple to the complex, are a snap. And autoscale gives you one-button setup for timing analysis.

You even get a color touchscreen and knob, or optional mouse with the new HP 16500A. Color lets you quickly distinguish between menu choices, measurements, and results...and find glitches more easily.

Probing made easy.

HP's new passive probes are lightweight and flexible...specially designed to grip easily and securely to your device under test. Plus, our preprocessors give you quick setups with most popular 8, 16, and 32-bit μPs, including the Motorola 68020 and Intel 80386. And if you've already invested in HP preprocessors, we offer you an easy upgrade path.

HP 1651A: full-featured logic analyzer for only $3,900.*

With 32 channels of 100 MHz transitional timing for just $3,900*, the HP 1651A gives the hardware engineer a highly economical, yet powerful debugging tool.

It's a full-featured logic analyzer with no compromises in state and timing capabilities (25 MHz state/100 MHz transitional timing on all channels), memory depth, triggering, or I/O features. It supports most popular 8-bit μPs with full inverse assembly. Plus it's compact, weighs just 22 lbs., and has an optional carrying case for easy transport.

HP 1650A: the new standard in general-purpose logic analysis for just $7,800.*

The HP 1650A features time-correlated state/state or timing/state operation on 80 channels. Plus eight sequence levels to meet your toughest triggering tasks. Yet it's priced below $8,000!

You get 25 MHz state/100 MHz transitional timing on all 80 channels, and preprocessor support for 8, 16, and 32-bit μPs. And, the

More value.

HP 1650A is portable, lightweight, and small enough to fit comfortably on a crowded workbench. It's also programmable, has a built-in disc drive for storing measurements, and provides hardcopy documentation.

HEWLETT PACKARD
16500A LOGIC ANALYSIS SYSTEM
System
Configuration
Print
PATTERN GENERATOR MASTER - 50 MHz
SCOPE ACQUISITION 400 MEGASAMPLE/s
SCOPE TIMEBASE 400 MEGASAMPLE/s
25 MHz STATE 100 MHz TIMING
1 GHz TIMING MASTER
Mouse
HP-IB
Controller
RS-232C
Printer

HP 16500A: modular system solution, priced your way.

The HP 16500A is modular, with the flexibility to meet your debug, characterization, or pass/fail test application needs today and tomorrow. You get a combination of state, timing, oscilloscope, and stimulus-response capabilities through your choice of performance modules. You can have up to 400 channels of 25 MHz state/100 MHz transitional timing. 8 channels of full-featured, simultaneous scope analysis. 80 channels of 1 GHz timing. Or 204 channels of 50 Mbit/sec stimulus.

Just $12,400* buys you a basic configuration with 80 channels of 25 MHz state/100 MHz transitional timing.

You can trigger one module with another. Time-correlate measurements between modules...400 Ms/sec scope and 1 GHz timing, for example. Even view state, timing, and analog on the same screen! Fully programmable, the HP 16500A eliminates the need for separate data storage and printer control. HP-IB and RS-232 are standard.

Now, bring real-world measurements into the CAE environment.

The HP 16500A is part of HP DesignCenter...a product development environment that unites engineers from IC design/verification to PCB design and test. By linking the HP 16500A with HP CAE, you can compare measurement results and simulated data on your workstation, and use measurement results as your simulator patterns.

Mail the card today!

For more information, fill out and mail the postage-paid reply card today. Call us direct at **1-800-752-0900.** Or contact your local HP sales office listed in the telephone directory white pages. Ask for the electronic instruments department.

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Excellent reliability, service, and support.

When you purchase a logic analyzer from HP, you get high reliability. The support you need to be productive with your instrument quickly. And a worldwide sales and service network to ensure your continuing satisfaction for years to come.

HP 1651A $3,900 *

The HP 1651A is a general-purpose, low-cost 32 channel logic analyzer with many features normally found on more expensive analyzers.

- 100 MHz transitional timing on all 32 channels.
- 25 MHz state on all channels.
- Support for most popular 8-bit μPs.
- Fully programmable, with built-in disc drive and hardcopy output.
- Portable and compact — weighs just 22 lbs.
- Optional 3-year protection.

HP 1650A $7,800 *

The HP 1650A is a general-purpose logic analyzer with a range of features to satisfy many requirements in design and test.

- 100 MHz transitional timing/25 MHz state on all 80 channels.
- Support for most popular 8, 16, and 32-bit μPs.
- Configurable as 2 totally independent analyzers.
- Fully programmable, with built-in disc drive and hardcopy output.
- Eight sequence levels with storage qualification, pattern and range recognizers.
- Glitch capture on all channels.
- Optional 3-year protection.

HP 16500A

The HP 16500A is a modular, configurable system solution that can meet a wide variety of logic analysis, oscilloscope, and stimulus-response measurement requirements.

- Configurable through your choice of performance modules:
  - 25 MHz state/100 MHz transitional timing (80 channels per module) $5,200 *
  - 400 Ms/sec 100 MHz bandwidth digitizing oscilloscope (2 channels per module) $5,500 *
  - 1 GHz timing (16 channel master) $7,800 *
  - 50 Mbits/sec pattern generation (12/48 channels per module) $3,700/$4,000 *
  - Mainframe $7,200 *
- Color touchscreen and knob, with optional mouse.
- Intermodule triggering.
- Two built-in disc drives.
- Fully programmable, with RS-232 and HP-IB interfaces.
- Optional 3-year protection.

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* U.S. list price.

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HP's integrated CAE/CAD

The HP DesignCenter offers integrated CAE/CAD software tools that accelerate the design process from idea to test. These tools, which run on the HP 9000 Series 300 technical workstations, improve productivity and communication throughout the product development process. So engineers can design faster and get products to market quickly.

Analog and digital design on one system

Both digital *and* analog designers can use the same HP design capture system, helping you to maximize return from your CAE/CAD investment. The system offers a number of features that help speed design, including a consistent environment of component libraries and schematics; hierarchical design entry; integrated documentation; on-line electrical rule checking; automatic component selection; and links between external design tools and design capture.

Faster microprocessor software development

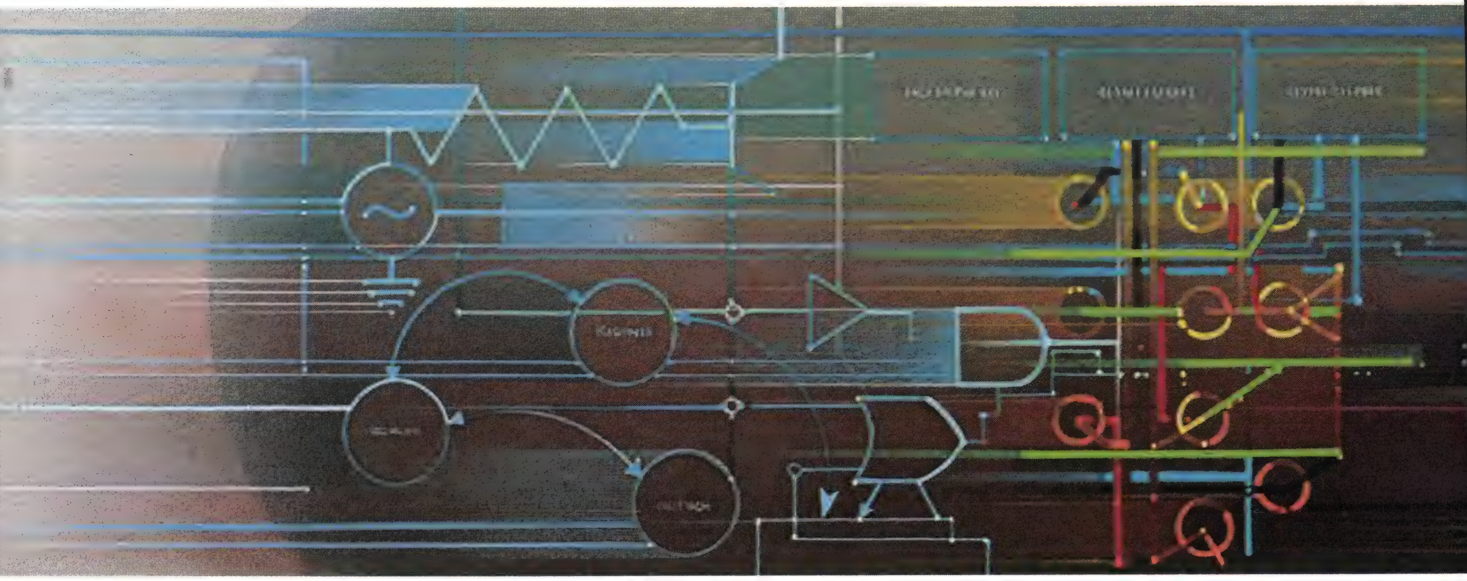
You get HP computer-aided software engineering. And some of the most advanced hardware and software integration tools available, including real-time emulation for over 40 processors. These tools let engineers tap the power of HP's microprocessor development environment to speed product development.

There's even a link to design capture from microprocessor system development so engineers can transfer programs directly to simulation, reducing both simulation setup time and the possibility of manual-entry errors.

Advanced PCB design tools for a head start in manufacturing

HP's automated printed circuit design system helps

Accelerate your product
from idea to design and



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urn engineering ideas into inished printed-circuit boards uickly. And gives you the ssurance that boards will match the approved design rom engineering and be ractical to manufacture.

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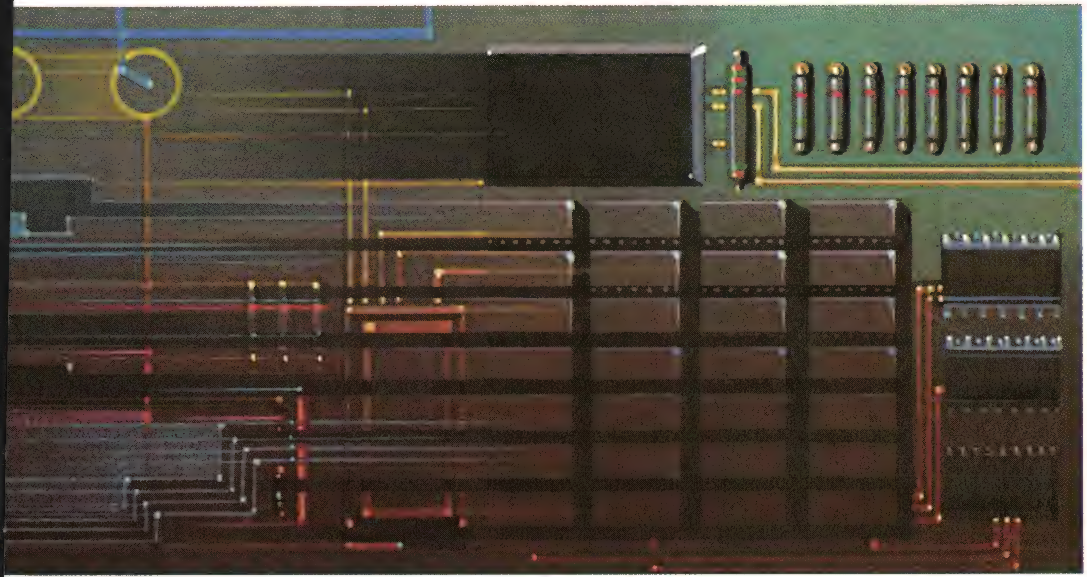

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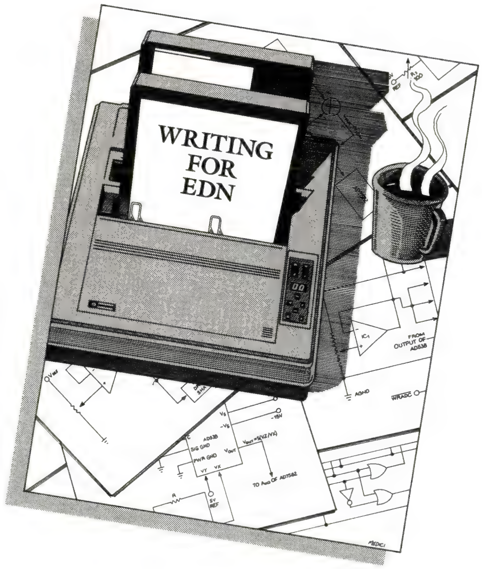

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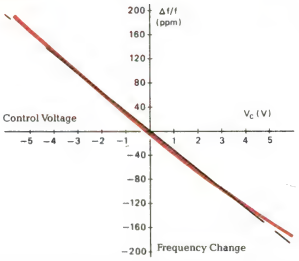
Ogilvy & Mather

PHILIPS' VCXO: FEWER HICCUPS IN

HIC!

Clearly, frequency precision is a key factor in smooth and efficient PLL performance. The fewer frequency hiccups, the better. Look at the usual voltage controlled oscillators in PLL circuits. Then look at the alternative developed by Philips – and compare the performance.
Philips VCXOs combine wide pullability with the advantages of quartz oscillators – frequency stability that resists the effects of temperature, ageing and loading. They offer a control-voltage/frequency characteristic of unsurpassed linearity,



symmetrical about the nominal frequency.
And that's not all. Philips VCXOs offer you a host
features, including low power consumption (30 m
6 mA from a single-ended 5 V supply), LS-TTL leve
output and very high frequency-stability (±20 pp
max) over their specified temperature range.
Philips VCXOs come in hermetically-sealed low-profile 4-pin packages, with pins spaced for 14-pin

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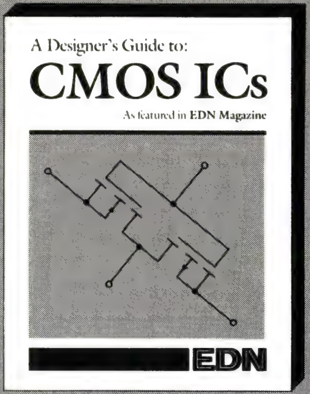

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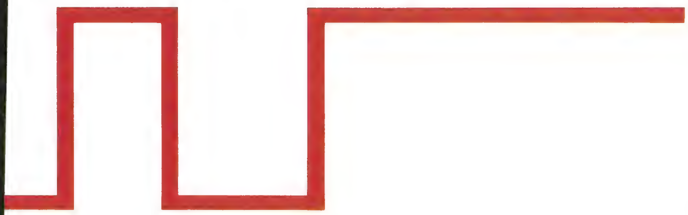
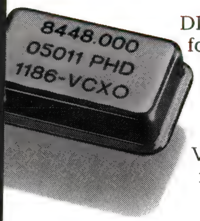
PLL CIRCUITS





DIL-package compatability. They're available at four centre frequencies, selected according to telephone standards in the 8 to 15 MHz range. Special types at other frequencies can be customized to suit your application.

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CIRCLE NO 16

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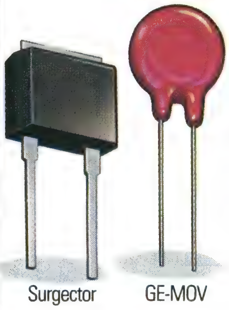
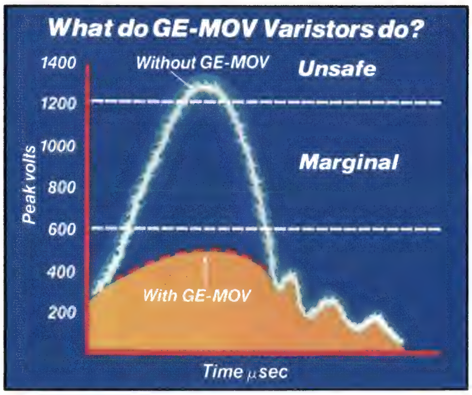


Now, whether you're designing small consumer products, industrial controls, high-rel military and aerospace systems, or anything in between, we have a surge protection solution for you. Because if one of our GE-MOV varistors isn't exactly right for the job, then one of our Surgectors probably will be.

Leader in Varistors.

We have the broadest line of varistors in the industry, with a range from 5V to 3500V, including the highest-energy MOV's in the industry (up to 70,000 peak amps and 10,000 joules).

They're widely used for incoming ac line protection in power supplies, clamping circuits and low voltage supply protection.



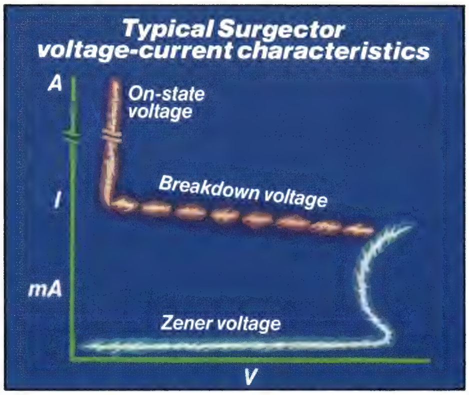
They're available in a variety of packages, including axial leaded, radial leaded, leadless surface mount, high-energy modules and connector-pin configurations. And they're all available for fast delivery.

Inventor of Surgector devices.

Surgector devices respond rapidly and handle a lot of energy. So they're ideal for protecting sensitive or expensive components from lightning strikes, load changes, switching transients, commutation spikes, electro-static discharge and line crosses.

How they work.

Surgector devices combine a zener diode and an SCR into one reliable, cost-effective device.



At low voltages, the Surgector is "off," representing high forward impedance (only 50nA leakage current). The instant clamping voltage is exceeded, the Surgector turns "on" and the zener immediately starts conducting. Within nanoseconds, the SCR turns on to handle heavy currents. Destructive surges are shunted to ground.

Once the surge passes, the device makes a fast transition back to the "off" state. You can choose from two-terminal, three-terminal or bi-directional devices.

We'll help you decide.

To determine which of these powerful technologies is best for you, plug into our applications hotline and let our experts help you decide.

For more information, call toll-free 800-443-7364, extension 21. Or contact your local GE Solid State sales office or distributor.

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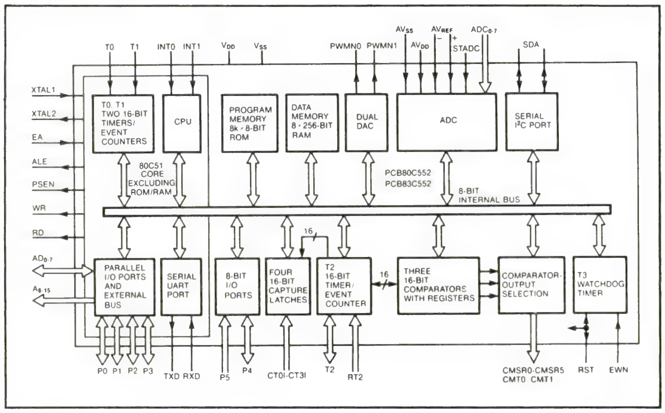
These three leading brands are now one leading-edge company. Together, we have the resources—and the commitment—to help you conquer new worlds.

READERS' CHOICE

Of all the new products covered in EDN's **August 20, 1987**, issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, find out what makes them special: Just circle the appropriate numbers on the Information Retrieval Service card, or refer to the indicated pages in our **August 20, 1987**, issue.



▲ CMOS MICROCONTROLLER

The PCB83C552 single-chip CMOS microcontroller offers numerous analog and digital I/O facilities that make it suitable for use in a wide variety of applications, such as medical, instrumentation, and industrial-control equipment (pg 93).

Philips.
Circle No 601
Signetics.
Circle No 602

DSP DESIGN TOOL

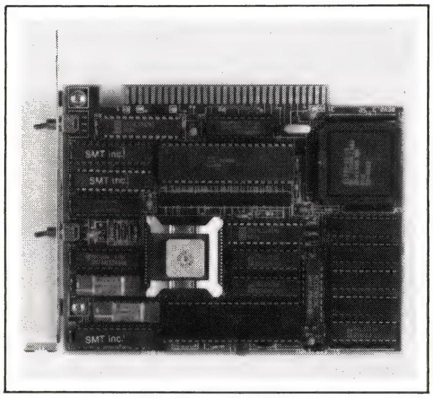
DSPlay is a software package that runs on an IBM PC or compatible computer that's equipped with at least 256k bytes of RAM and a CGA or equivalent color-graphics board (pg 308).

Burr-Brown Corp.
Circle No 607

▲ PLD PROGRAMMER

The Sailor-PAL is a universal PLD programmer that requires no personality adapters. It handles 20-, 24-, and 28-pin devices (pg 306).

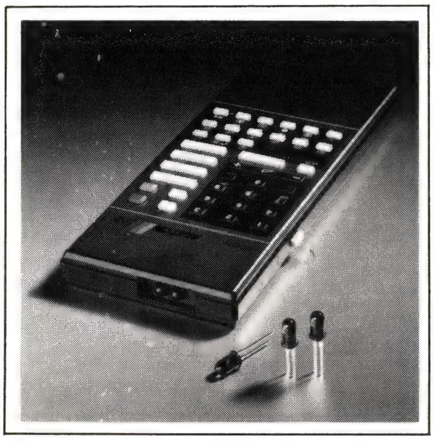
Advin Systems Inc.
Circle No 606



▲ IBM PC/XT ACCELERATOR

The XT-286 Speed Card is a half-slot add-in board for the IBM PC/XT. It has an 80286 μP that runs at 10 MHz and a cache memory that has zero wait states (pg 294).

SMT Inc.
Circle No 605



◀ INFRARED LEDs

The CQW-58A, -89A, and -89B infrared LEDs feature a switching speed of 30 nsec and allow you to increase the data rate between remote equipment and control handsets (pg 266).

Philips.
Circle No 603
Amperex Electronic Corp.
Circle No 604

SIGNUM SYSTEMS' SOLUTION TO 8051/52 DEVELOPMENT PROBLEMS

- **REAL-TIME,** nonintrusive emulation up to 16 Mhz
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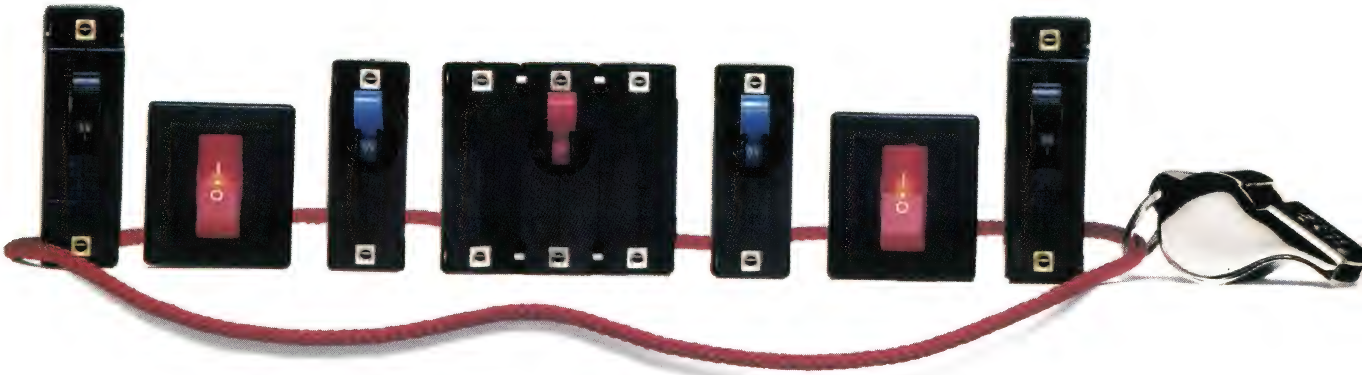

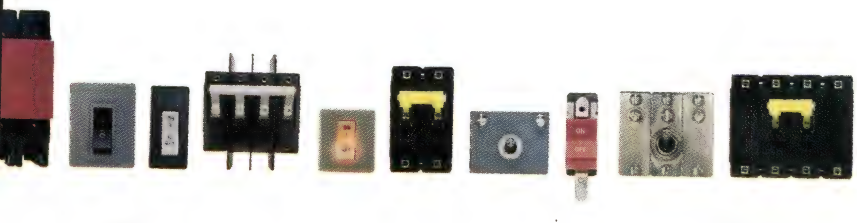

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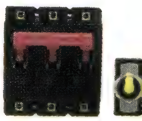

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LEADTIME INDEX

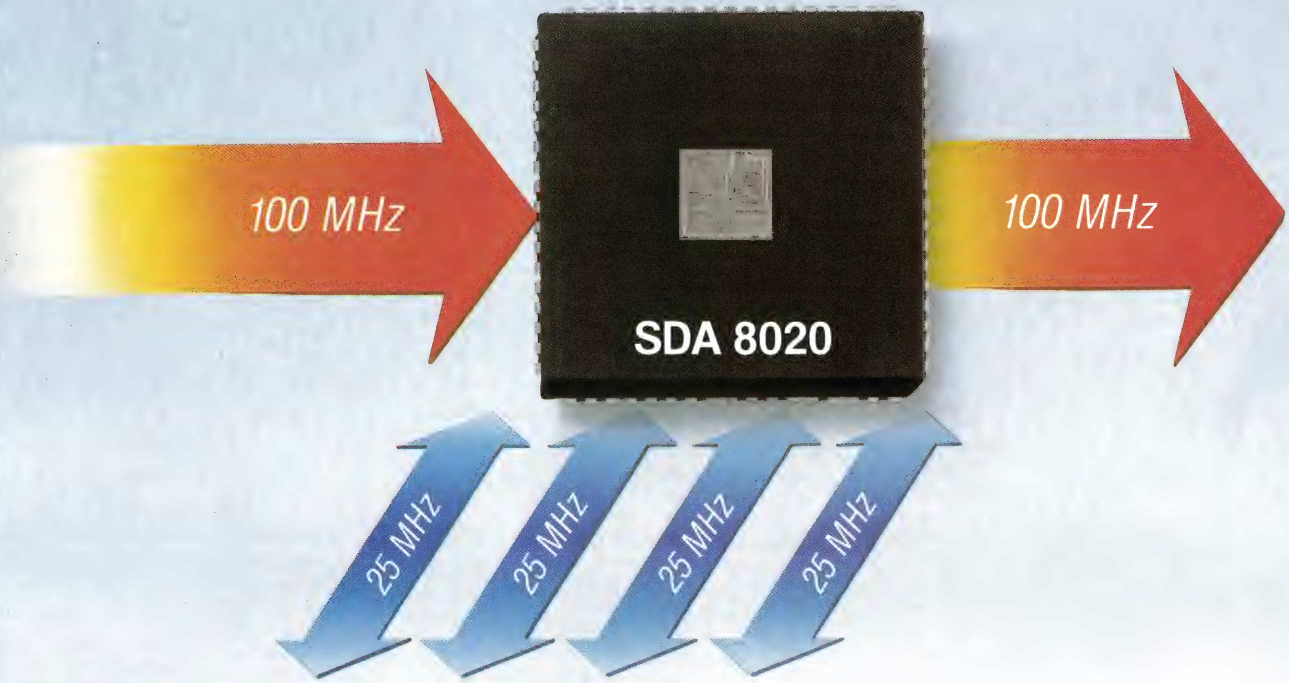
Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average (weeks)	Last month's average (weeks)
TRANSFORMERS								
Toroidal	0	25	50	25	0	0	8.6	5.9
Pot-Core	8	15	46	23	8	0	9.7	7.7
Laminate (power)	0	40	27	27	6	0	9.2	6.7
CONNECTORS								
Military panel	0	0	75	25	0	0	9.9	5.3
Flat/Cable	27	27	40	6	0	0	5.0	4.3
Multi-pin circular	0	29	71	0	0	0	6.6	7.9
PC	0	44	56	0	0	0	5.8	5.6
RF/Coaxial	17	33	42	8	0	0	5.6	6.6
Socket	37	26	32	5	0	0	4.1	5.2
Terminal blocks	19	43	38	0	0	0	4.3	5.7
Edge card	19	19	43	19	0	0	7.0	5.8
D-Subminiature	20	20	47	13	0	0	6.4	6.3
Rack & panel	7	8	69	8	8	0	8.9	7.7
Power	9	46	36	9	0	0	5.7	6.9
PRINTED CIRCUIT BOARDS								
Single-sided	5	54	36	5	0	0	5.3	4.9
Double-sided	3	35	48	14	0	0	7.0	5.2
Multi-layer	0	12	63	25	0	0	9.3	8.1
Prototype	5	70	25	0	0	0	4.1	3.8
RESISTORS								
Carbon film	38	31	28	3	0	0	3.7	3.1
Carbon composition	38	33	29	0	0	0	3.3	3.2
Metal film	36	29	32	5	0	0	4.1	3.5
Metal oxide	18	29	41	12	0	0	6.0	2.8
Wirewound	14	24	48	9	5	0	7.2	6.6
Potentiometers	27	27	46	0	0	0	4.5	6.9
Networks	19	31	31	19	0	0	6.3	5.1
FUSES	35	35	20	10	0	0	4.2	2.6
SWITCHES								
Pushbutton	26	21	32	21	0	0	6.4	5.6
Rotary	15	35	35	15	0	0	6.2	6.7
Rocker	18	29	35	18	0	0	6.4	5.0
Thumbwheel	0	25	42	33	0	0	9.3	6.4
Snap action	15	31	31	23	0	0	7.0	5.5
Momentary	23	15	39	23	0	0	7.1	5.8
Dual in-line	30	20	20	30	0	0	6.9	5.9
WIRE AND CABLE								
Coaxial	33	20	47	0	0	0	4.3	2.8
Flat ribbon	33	22	34	11	0	0	5.1	4.1
Multiconductor	15	23	54	8	0	0	6.2	3.8
Hookup	48	28	24	0	0	0	2.8	1.6
Wire wrap	50	33	17	0	0	0	2.3	5.0
Power cords	36	18	27	14	5	0	6.0	4.4
POWER SUPPLIES								
Switcher	20	33	27	20	0	0	6.2	7.4
Linear	10	40	30	20	0	0	6.7	8.2
CIRCUIT BREAKERS	16	47	21	16	0	0	5.6	7.5
HEAT SINKS	11	56	28	5	0	0	4.8	4.8
RELAYS								
General purpose	32	37	21	10	0	0	4.4	6.1
PC board	10	37	21	32	0	0	7.7	7.4

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average (weeks)	Last month's average (weeks)
RELAYS								
Dry reed	0	50	17	33	0	0	8.0	7.9
Mercury	17	33	17	33	0	0	7.5	7.6
Solid state	8	50	17	17	8	0	7.5	6.0
DISCRETE SEMICONDUCTORS								
Diode	39	29	21	7	0	4	4.8	8.0
Zener	37	26	21	11	5	0	5.4	7.4
Thyristor	8	25	42	25	0	0	8.0	6.6
Small signal transistor	9	37	27	27	0	0	7.5	5.5
MOSFET	15	23	31	31	0	0	7.9	6.2
Power, bipolar	20	20	20	40	0	0	8.4	5.4
INTEGRATED CIRCUITS, DIGITAL								
Advanced CMOS	8	17	50	25	0	0	8.4	11.7
CMOS	26	21	32	21	0	0	6.4	8.9
TTL	27	27	26	20	0	0	6.0	6.5
LS	44	6	25	25	0	0	6.1	6.6
INTEGRATED CIRCUITS, LINEAR								
Communication/Circuit	11	11	56	22	0	0	8.2	6.3
OP amplifier	14	21	36	29	0	0	7.9	7.9
Voltage regulator	21	26	42	11	0	0	5.8	6.8
MEMORY CIRCUITS								
RAM 16k	20	20	30	30	0	0	7.7	7.9
RAM 64k	23	15	39	23	0	0	7.1	8.3
RAM 256k	37	0	27	27	9	0	8.7	7.8
RAM 1M-bit	17	17	33	17	16	0	10.0	8.8
ROM/PROM	30	0	50	20	0	0	7.1	9.0
EPROM 64k	21	14	36	29	0	0	7.7	9.4
EPROM 256k	17	8	42	33	0	0	8.8	8.8
EPROM 1M-bit	13	12	50	25	0	0	8.3	13.9
EEPROM 16k	10	20	40	30	0	0	8.5	12.3
EEPROM 64k	10	30	30	30	0	0	8.0	13.0
DISPLAYS								
Panel meters	7	29	21	36	7	0	9.9	6.6
Fluorescent	0	0	40	60	0	0	12.5	10.1
Incandescent	14	29	14	43	0	0	8.6	7.6
LED	30	15	20	35	0	0	7.5	6.0
Liquid crystal	0	27	33	40	0	0	9.7	9.9
MICROPROCESSOR ICs								
8-bit	14	33	33	20	0	0	6.8	8.9
16-bit	13	13	47	27	0	0	8.3	8.1
32-bit	0	9	36	46	9	0	12.5	8.5
FUNCTION PACKAGES								
Amplifier	0	22	45	33	0	0	9.4	7.5
Converter, analog to digital	0	20	50	30	0	0	9.3	8.3
Converter, digital to analog	0	25	50	25	0	0	8.6	8.3
LINE FILTERS	20	0	60	20	0	0	7.9	7.9
CAPACITORS								
Ceramic monolithic	28	32	32	8	0	0	4.8	5.9
Ceramic disc	38	19	33	10	0	0	4.7	6.0
Film	38	19	31	12	0	0	5.0	7.3
Aluminum electrolytic	18	41	27	14	0	0	5.5	8.2
Tantalum	35	15	35	15	0	0	5.6	7.3
INDUCTORS	21	22	43	14	0	0	6.3	5.8

Source: *Electronics Purchasing* magazine's survey of buyers

SIEMENS



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0.050-in. (1.27-mm) contact wipe helps assure reliable connections.

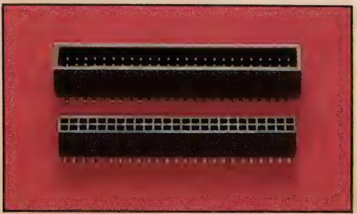
Du Pont RIB-CAGE™ connectors feature a three-rib contact that delivers 100 grams of normal force.

Patented RIB-CAGE design is highly resistant to shock and vibration.

Big performance. Little package.

Du Pont RIB-CAGE™ connectors deliver 100-gram normal force in miniature/microminiature interconnects.

The patented RIB-CAGE connector terminal design, magnified above, is how Du Pont packs 0.100-in. centerline connector performance into miniature packages like the 50-position vertical card connector shown in inset photo.



Actual size of 50-position 0.050-in. (1.27-mm) vertical surface-mount RIB-CAGE card connector and mating male header.

The exclusive angled rib design creates a contact area large enough to produce a normal force of 100 grams, with remarkably high shock and vibration resistance. The 0.050-in. (1.27-mm) contact wipe helps assure reliable contacts even through repeated cycles.

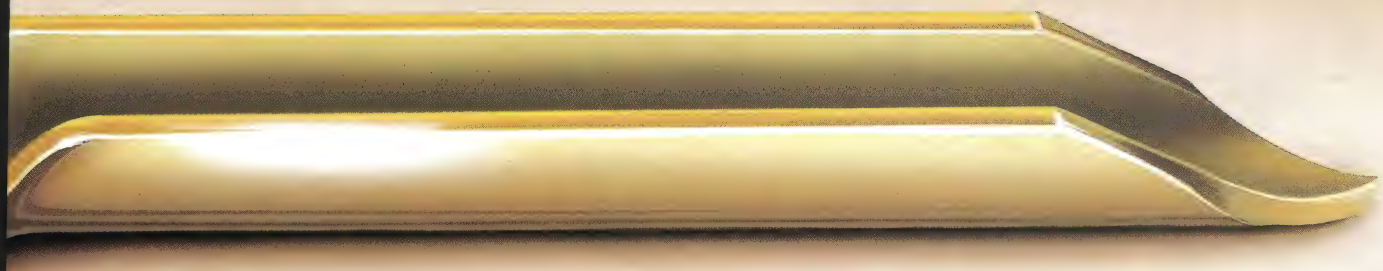
You also get inductance, capacitance, and impedance values that deliver signal speeds faster than 0.100-in. centerline designs plus high current capacity (see chart) and low circuit resistance.

That's what we mean by big performance.

Little package, high density.

Your designs benefit from a significant increase in surface density. RIB-CAGE connectors on 0.050-in. centers take up *one-eighth* the volume of 0.100-in. centerline connectors. And the

Berg Electronics is now



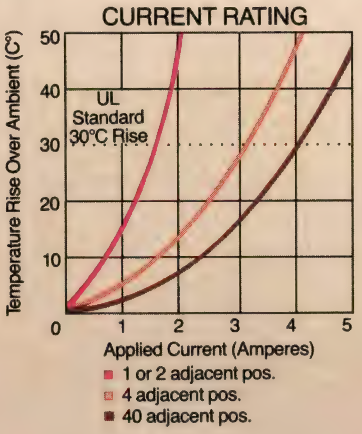
Shown above: 60X illustration of terminal used in RIB-CAGE connectors. Actual length is 0.250 in.

low profiles delivered by RIB-CAGE connectors mean tight stacking: 0.225 in. (5.72 mm) between substrates for through-mounts, 0.252 in. (6.40 mm) for surface-mounts. Profiles as low as 0.18 in. have been achieved for special applications.

Plenty of design flexibility.

The RIB-CAGE product family, currently tooled on 0.050-in. centers, offers the choice of vertical card connectors, interboard connectors, and pin grid array sockets. Through- and surface-mount configurations are available as well as single- and dual-entry designs.

The versatile RIB-CAGE design can accommodate a variety of applications including wire products both discrete and cable and right-angle horizontal card connectors.



Each RIB-CAGE connector is made with a plastic lead-in to protect the contact during mating. Polarized housings assure proper mating. And housings of Du Pont RYNITE® polyester resins resist vapor phase soldering temperatures.

Contact Du Pont for RIB-CAGE specifics.

Fill out the reader service card for complete information on RIB-CAGE connectors. For a sample kit of current RIB-CAGE connectors, call us toll-free, or write on your letterhead. Write to Rib-Cage Product Manager, Du Pont Connector Systems, 515 Fishing Creek Road, New Cumberland, PA 17070. Or make the Du Pont Connection: 800 932-7979.

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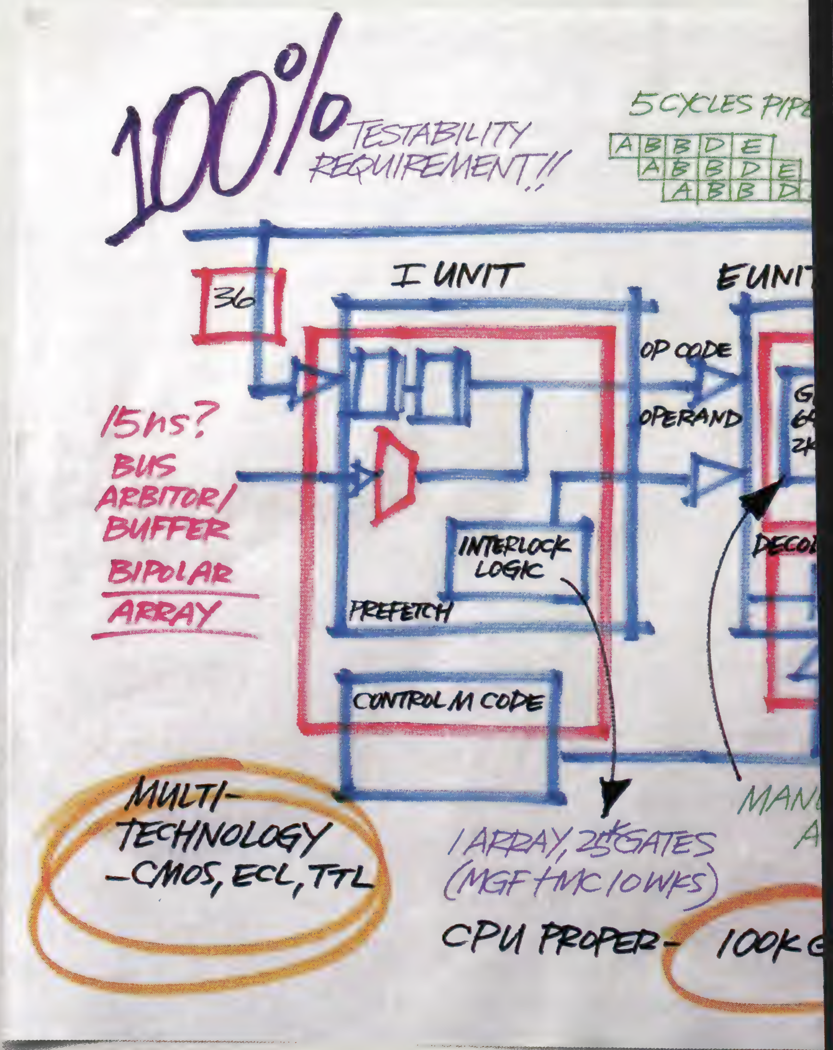

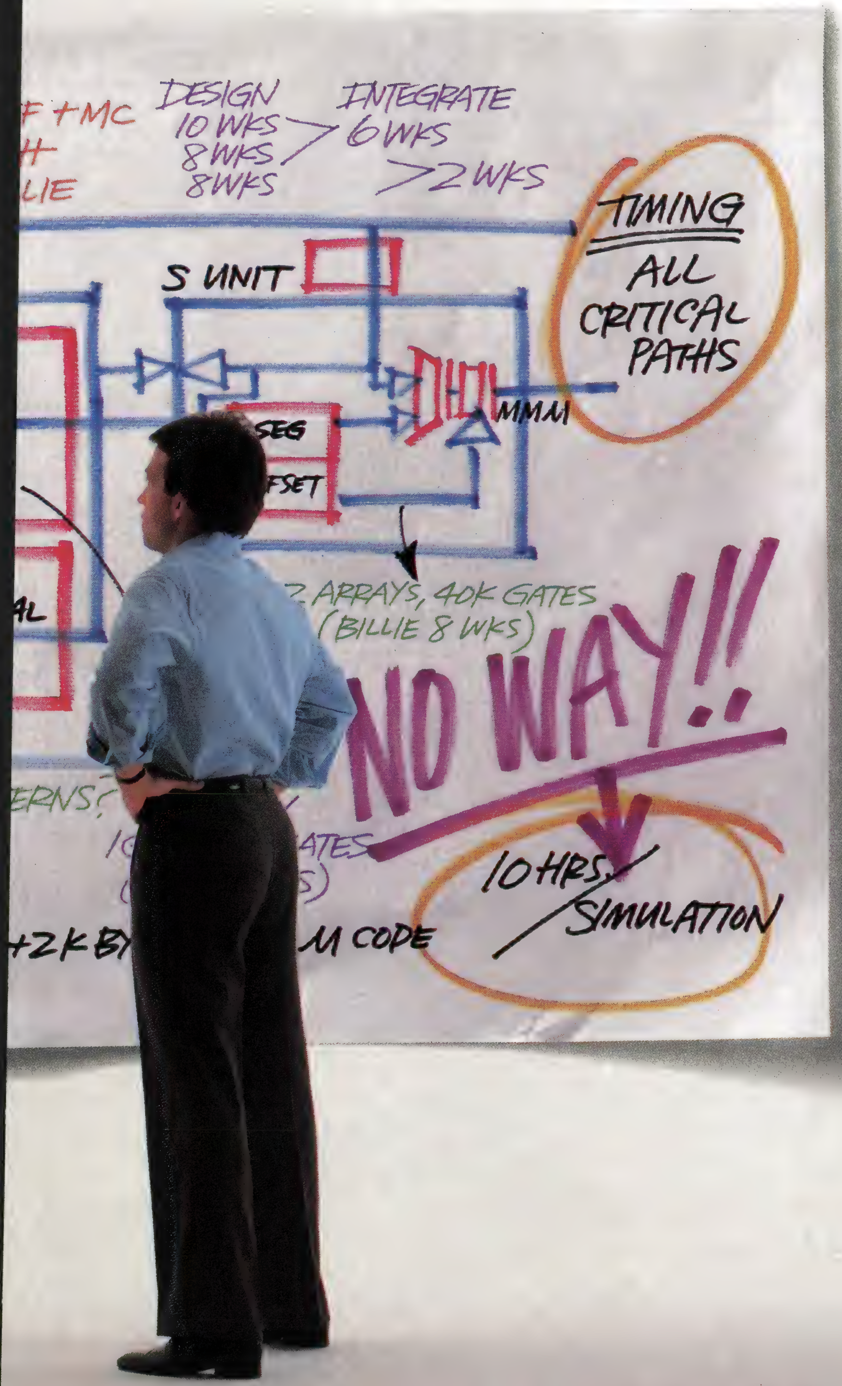

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CIRCLE NO 168

Solve special decoupling problems

MICRO/Q capacitors with special pinout configurations give you design flexibility you can't get with standard techniques to solve decoupling and routing problems. Choose MICRO/Q for 8-, 16-, or 32-bit microprocessors, ECL devices, and many other devices where power and ground are not at conventional positions. You'll get superior noise suppression and design ease.

CIRCLE NO 126

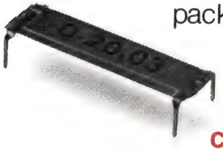
Improve existing board performance

MICRO/Q capacitors can be retrofitted to solve noise problems on existing boards. Because MICRO/Q caps share mounting holes with existing IC pins, no board redesign is required. Effective decoupling becomes a matter of adding one insertion step.

CIRCLE NO 127

Simplify board layout and get a choice

MICRO/Q ceramic decoupling capacitors share board mounting holes with IC pins. You don't have to waste space on additional holes, as you do for standard caps. Simplifying board design opens up two very attractive options. Add more active devices with increased packaging density in the same space, or design the same package on a smaller board. Either way, you win with MICRO/Q.



CIRCLE NO 128

noise problems... space problems...

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Design noise out of PGA and LCC packages

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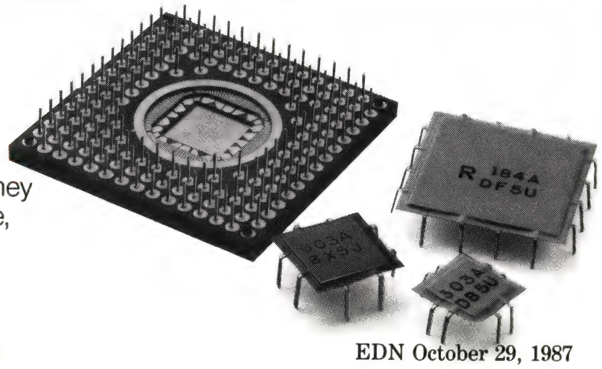

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CIRCLE NO 167

Workstation manufacturers have been very active lately: They have introduced many "super" workstations and restructured the prices of many of the older systems. Affordable workstations have also become powerful enough to exploit popular standards, particularly X Windows, Unix, and Ethernet.

By embracing relevant standards, today's workstations *are breaking down the wall that has prevented different computer networks from interacting and accessing each other's resources. (Photography by R G Muna; design by Morduk A Sayad; photo courtesy Sun Microsystems Inc)*

KEEPING AMERICA COMPETITIVE

Workstations

Special Report

David Shear, *Regional Editor*

Various workstation standards have existed for many years, but their acceptance has been hampered for two reasons. It takes time for workable standards to evolve and become accepted, and standard implementations are usually slower than nonstandard approaches. Workstation users often speak in favor of standards, but they also want the highest performance. Typically, to get the greatest level of performance, you had to bypass layers of software standards and interact directly with the hardware.

At long last, workable standards have evolved, and powerful, affordable workstations are available that embrace those standards (see **Table 1** on pg 172). In today's workstation market, the de facto operating-system standard is Unix. (Berkeley 4.X seems to be merging with AT&T's System V, resulting in one hybrid Unix standard.) The networking-system window manager is X Windows (version 11); almost all of the new workstations support some form or another of X Windows. The local-area network is Ethernet. Because the acceptance of these three standards is gaining momentum, you can now sit at your workstation and access any of the multitudinous resources of the other workstations on the network; indeed, your computer actually becomes a single network of shared resources.

You can imagine the incredible performance and flexibility that this combination of standards and workstations has to offer the average engineer. For example, using X Windows you can use your workstation to run a program from another computer, interacting with the program as if it were running on your machine (see **box,** "X Windows offers workable windowing environment"). Many windows can be open simultaneously, all running different programs and each running on any machine in the system—even if the machines are from different vendors.

Although imaginative, this scenario depicts a real-life situation. You can actually achieve this type of workstation performance now. Currently not much software is available to take advantage of *all* of these standards but, because it is so easy to port software to the X Windows environment, many application packages will soon be on the market. As a user (and potential customer), you can hurry this process by adopting these standards—by choosing a workstation that runs Unix, interfaces to Ethernet, and uses X Windows.

One of the new RISC-based workstations, *the HP Model 825SRX, operates at a 12.5-MHz clock rate and offers twice the performance of the company's 68020-based Model 350.*

You'll find that evaluating the performance of these new workstations is a less-than-straightforward task. As far as a vendor is concerned, the easiest way to cite performance is by using MIPS (million instructions per second), but this number actually tells you, the user, very little. In fact, the acronym might as well stand for "meaningless indication of performance." If you look at how many instructions a machine can execute in one second without determining what that instruction is doing, you'll end up with a misrepresented number. For example, if a RISC (reduced instruction set computer) machine has a 16-MHz clock and each instruction executes in one cycle, should you classify it as a 16-MIPS machine? And, how do RISC MIPS compare to CISC (complex instruction set computer) MIPS?

The two problems with standards is the length of time it takes for a workable standard to evolve and the user's perception of reduced performance.

A small portion of your desk *is all you need for Digital Equipment Corp's VAXstation 2000.*

In an attempt to deal with this nebulousness, many vendors use what they call VAX MIPS. They begin with the premise that a VAX 11/780 is a 1-MIPS computer; then, they run a series of benchmarks and compare the results with what the VAX 11/780 is capable of doing. These results vary, depending on the benchmark being used. The most popular benchmarks are Whetstone, Dhrystone, and Linpack.

The Whetstone benchmarks are Fortran programs derived from an analysis of 1000 programs in an attempt to represent an average program instruction mix. The programs include floating-point and integer calculations, transcendental functions, array manipulation, and conditional jump statements. The Dhrystone benchmark simulates a high-level C programming environment and contains 100 statements with 53% assignments, 32% control statements, and 15% function calls. The Linpack benchmark solves a dense system of linear equations to provide a measure of floating-point performance.

Benchmarks can confuse the issue, too

To help you comprehend how confusing and arbitrary this practice of computing MIPS actually can be, consider a couple of examples provided by the manufacturers. The Sun 4/260 can do 19,000 Dhrystones/sec, whereas the VAX 11/780 can do 1428, and thus the Sun machine executes 13.3 times as many Dhrystones/sec as the VAX. Running the single-precision Linpack benchmark, however, the Sun 4/260 is only 6.4 times as fast as the VAX. Sun rates the workstation as a 10-MIPS machine.

Another example is Hewlett-Packard's Model 825SRX. This machine executes about nine times as many Dhrystones/sec as does the VAX 11/780. Running the single-precision Linpack benchmark, the 825SRX is less than three times as fast as the VAX 11/780. Hewlett-Packard classifies the 825SRX as an 8-MIPS workstation.

The Dhrystone, Whetstone, and Linpack benchmarks measure raw CPU power. They don't measure the overall efficiency of a system. Often these benchmarks can fit within the system's cache memory, and therefore only a very small portion of the system's peformance is measured, because the benchmarks are executing from the cache memory and don't have to access the main memory. The raw CPU speed of a computer doesn't tell you what the I/O bandwidth and system performance will be. You can usually assume that a 10-MIPS workstation will run your application faster than will a 1-MIPS machine, but you can't determine just how much faster.

The best way to evaluate a system's performance is to run your actual application. Normally you can't run your application as your benchmark, but check with your vendor. You might be pleasantly surprised. The next best thing is to look at all of the available benchmarks and decide the relative importance of each with your application in mind. Base your performance estimate on an aggregate of all of the benchmarks.

RISC-based workstations are here

Despite the lack of a single, reliable measure of workstation performance, the hardware available to take advantage of Unix, X Windows, and Ethernet has undoubtedly taken a quantum leap in terms of performance. This giant step is due in large part to the RISC architecture. In the past six months, Sun, Hewlett-Packard, and Silicon Graphics have introduced affordable RISC-based workstations.

The new Sun 4 Series of superworkstations is based on a 32-bit RISC μP called Sparc (Scalable Processor Architecture). To meet the corporate goal of doubling performance every year, Sun decided to develop its own μP; the vendor rates the performance of the Sun 4/260 at about 2½ times that of the 25-MHz, 68020-based Sun 2/260.

The Sun 4 family is source-code compatible with Sun's existing family of 68020-based products. Porting

X Windows offers workable windowing environment

Window managers have been available on many workstations for some time now. These windows allow you to access multiple applications simultaneously from several overlapping text and graphics windows. You can manipulate these windows in various ways: moving, sizing, overlapping, hiding, and iconizing.

Window managers are powerful tools but until recently have suffered from some serious problems. For one thing, there have been too many different window systems. As a user, you had many different controls to remember. Also, the windows were very machine and application dependent; even after you became comfortable with one application's windowing system, you still had another set of controls to learn for a different application. Another drawback was the impossibility of effectively accessing a network from within the windowing environment.

Ideally all manufacturers would use a common window manager and then all applications would look similar. Also, if this same window manager allowed networking, you could run applications on any machine on the network just as if they were running on your machine.

The problems are solved

X Windows, which was developed at MIT, provides high-performance, high-level, device-independent graphics. All of the major workstation manufacturers have embraced it. Most have built software-development tool kits to facilitate its use, thus greatly simplifying the creation of sophisticated user interfaces.

With X Windows, even if workstations are from different vendors, programs can run on one workstation and be displayed on another. Computation-intensive applications can run on a minicomputer or mainframe computer without ever requiring that you change the user interface.

Another major advantage that X Windows offers is device independence (**Fig A**). In the past, it was always necessary to alter each software package to take advantage of a new display. With the X Windows architecture, a server does all the display manipulation. The server receives requests from all the application programs using the display and carries them out. Thus, entire networks of workstations with different display hardware can utilize the same executable application code. As new displays are added, the only requirement is a new server that understands X Windows.

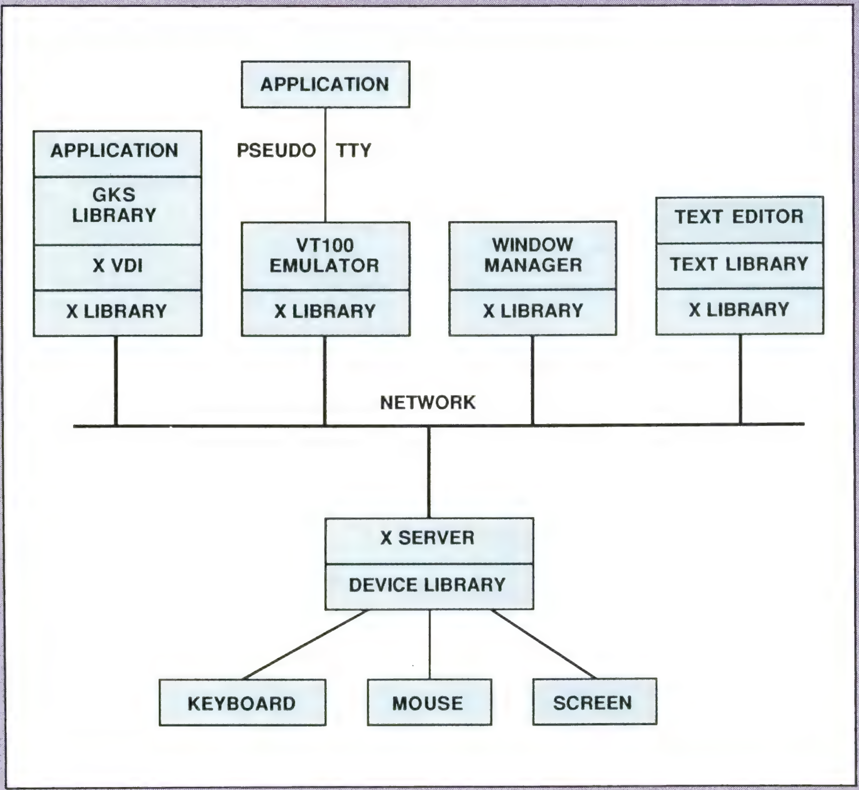

*Fig A—**X Windows is hardware independent.** A server takes care of all the display-manipulation requests from the various application programs, so different workstations can use the same executable application code.*

TABLE 1—WORKSTATIONS

COMPANY	PRODUCT	BASE PRICE	CPU	CLOCK FREQUENCY (MHz)	OPERATING SYSTEM	MEMORY (MIN/MAX) (BYTES)	GRAPHICS	
							MONITOR	RESOLUTION (PIXELS)
APOLLO COMPUTER	DOMAIN SERIES 3000	$4990	MC68020	12	UNIX SYSTEM V AND BERKELEY 4.2 AND AEGIS	2M/8M	15-IN. MONOCHROME 19-IN. MONOCHROME 15- OR 19-IN. COLOR	1024×800 1280×1024 1024×800
	DOMAIN SERIES 4000	$13,900	MC68020	25	UNIX SYSTEM V AND BERKELEY 4.2 AND AEGIS	4M/32M	19-IN. MONOCHROME 15- OR 19-IN. COLOR	1280×1024 1024×800
	DN5XX TURBO WORKSTATIONS	$46,900	MC68020	20	UNIX SYSTEM V AND BERKELEY 4.2 AND AEGIS	8M/32M	19-IN. COLOR	1280×1024
APPLE COMPUTER	MACINTOSH II	$4796	MC68020	15.7	MACINTOSH OS A/UX (UNIX SYSTEM V AND BERKELEY 4.2)	1M/8M	12-IN. MONOCHROME 13-IN. COLOR	640×480 640×480
DIGITAL EQUIPMENT CORP	VAXSTATION 2000	$4600	MICROVAX II	40	ULTRIX (UNIX) OR VMS	4M/6M	15- OR 19-IN. GRAY SCALE 15- OR 19-IN. MONOCHROME 15- OR 19-IN. COLOR	1024×864 1024×864 1024×864
	VAXSTATION II	$26,000	MICROVAX II	40	ULTRIX (UNIX) OR VMS	2M/16M	19-IN. MONOCHROME	1024×864
	VAXSTATION II/GPX	$19,900	MICROVAX II	40	ULTRIX (UNIX) OR VMS	3M/16M	19-IN. GRAY SCALE 19-IN. COLOR	1024×864 1024×864
	VAXSTATION 3200	$19,900	CMOS CPU (VAX BASED)	22	ULTRIX (UNIX) OR VMS	8M/16M	19-IN. GRAY SCALE 19-IN. COLOR	1024×864 1024×864
	VAXSTATION 3500	$50,400	CMOS CPU (VAX BASED)	22	ULTRIX (UNIX) OR VMS	16M/32M	19-IN. GRAY SCALE 19-IN. COLOR	1024×864 1024×864
HEWLETT-PACKARD	HP 9000 MODEL 318M	$4990	MC68020	16.67	HP-UX	4M/4M	17-IN. MONOCHROME	1028×768
	HP 9000 MODEL 330	$12,950	MC68020	16.67	HP-UX	4M/8M	19-IN. MONOCHROME 16- OR 19-IN. COLOR	1280×1024 1280×1024
	HP 9000 MODEL 350	$25,100	MC68020	25	HP-UX	4M/48M	19-IN. MONOCHROME 16- OR 19-IN. COLOR	1280×1024 1280×1024
	HP 9000 MODEL 825SRX	$69,500	HP PRECISION ARCHITECTURE	12.5	HP-UX	8M/48M	19-IN. COLOR	1280×1024
SILICON GRAPHICS	IRIS 4D/60 TURBO	$64,900	RISC μP (MIPS COMPUTERS)	12.5	UNIX SYSTEM V AND BERKELEY 4.3	4M/12M	19-IN. COLOR	1280×1024
	IRIS 3130	$59,900	MC68020	16	UNIX SYSTEM V AND BERKELEY 4.3	8M/16M	19-IN. COLOR	1024×768
SUN MICROSYSTEMS	SUN 3/50	$4995	MC68020	15	SUN OS (UNIX SYSTEM V AND BERKELEY 4.2)	4M/4M	19-IN. MONOCHROME	1152×900
	SUN 3/60	$7900 (MONOCHROME) $9900 (COLOR)	MC68020	20	SUN OS	4M/24M	19-IN. GRAY SCALE 19-IN. HIGH-RESOLUTION MONOCHROME 19-IN. MONOCHROME 16- OR 19-IN. COLOR	1152×900 1600×1280 1152×900 1152×900
	SUN 3/160	$19,900 (MONOCHROME) $27,900 (COLOR)	MC68020	16.67	SUN OS	4M/16M	19-IN. MONOCHROME 19-IN. GRAY SCALE 19-IN. COLOR	1152×900 1152×900 1152×900
	SUN 3/260	$28,900	MC68020	25	SUN OS	8M/32M	19-IN. MONOCHROME 19-IN. HIGH-RESOLUTION MONOCHROME 19-IN. GRAY SCALE 19-IN. COLOR	1152×900 1600×1280 1152×900 1152×900
	SUN 4/260	$39,900	MB86900 (RISC)	16.67	SUN OS	8M/128M	19-IN. MONOCHROME 19-IN. HIGH-RESOLUTION MONOCHROME 19-IN. GRAY SCALE 19-IN. COLOR	1152×900 1600×1280 1152×900 1152×900

COLOR/ PALETTE	FLOATING-POINT PROCESSOR	STORAGE (BYTES)			LOCAL-AREA NETWORK
		FLOPPY DISK	HARD DISK	TAPE	
16/4096 OR 256/16.7M	MC68881	5¼ IN. 1.2M	72M-348M	60M	APOLLO TOKEN RING OR ETHERNET
256/16.7M	MC68881	5¼ IN. 1.2M	155M-348M	60M	APOLLO TOKEN RING OR ETHERNET
256/16.7M OR 1.3M/16.7M	MC68881 OPTIONAL FPX		155M-696M	60M	APOLLO TOKEN RING OR ETHERNET
	MC68881	3½ IN. 800k	20M-80M		APPLETALK, ETHERNET
16/16.7M	78132 (PROPRIETARY)	5¼ IN. 1.2M	44M-159M	95M	ETHERNET
	78132 (PROPRIETARY)	DUAL 5¼ IN. 400k	71M-159M	95M	ETHERNET
16 OR 256/16.7M	78132 (PROPRIETARY)	DUAL 5¼ IN. 400k	71M-159M	95M	ETHERNET
256/16.7M	CMOS FLOATING-POINT UNIT		71M-318M	95M	ETHERNET
256/16.7M	CMOS FLOATING-POINT UNIT		280M-560M	296M	ETHERNET
	MC68881	3½ IN. 270k-630k 5¼ IN. 270k	101M-571M	15M-140M	ETHERNET
256/16.7M	MC68881 OPTIONAL FLOATING-POINT ACCELERATOR	3½ IN. 270k-630k 5¼ IN. 270k	101M-571M	15M-140M	ETHERNET
256/16.7M	MC68881 OPTIONAL FLOATING-POINT ACCELERATOR	3½ IN. 270k-630k 5¼ IN. 270k	10M-571M	15M-140M	ETHERNET
16/16.7M	HP PROPRIETARY		132M-571M	15M-140M	ETHERNET
4096/16.7M OR 16.7M/16.7M	PROPRIETARY		170M-340M	60M	ETHERNET
4096/16.7M OR 16.7M/16.7M	WEITEK 1064		170M	60M	ETHERNET
			71M-141M	60M	ETHERNET, GM-MAP
256/16.7M	MC68881		71M-282M	60M	ETHERNET, GM-MAP
256/16.7M	MC68881		141M-1.2G	60M	ETHERNET, GM-MAP
256/16.7M	MC68881		280M-2.3G	60M	ETHERNET
256/16.7M	WEITEK 1164/1165		280M-2.3G	60M	ETHERNET

A RISC-based *Sun 4/260 from Sun Microsystems uses a proprietary μP to more than double the performance level of the 68020-based 2/260.*

code from the Sun 2 and Sun 3 families requires only the recompilation of programs. This level of compatibility also allows all systems to use the same software and be combined in network installations. If you already have a Sun 3, you can upgrade to a Sun 4 by swapping CPU boards. Both machines use a triple-height, quad-depth Eurocard board. Two of the three bus connectors provide internal communications between boards; the third is a VME bus for I/O access.

Hewlett-Packard has three new advanced computer systems that employ a RISC architecture. Model 825SRX is the family's workstation and is the first workstation based on HP's Precision Architecture. The company claims that the 12.5-MHz 825SRX's performance is twice that of the 25-MHz, 68020-based Model 350. Model 825SRX uses the HP-UX operating system, which adheres to AT&T's Unix System V. The workstation is object-code compatible with all Series 800 products and is source-code compatible with all Series 300 products.

The Iris 4D/60 Turbo workstation from Silicon Graphics is the third RISC-based machine to be introduced recently. The machine uses a 32-bit RISC μP from MIPS Computers (Sunnyvale, CA), a floating-point accelerator, and a 10-MHz geometry engine for high-speed graphics.

Non-RISC workstations still have a place

Don't be misled into believing that RISC-based workstations are making non-RISC machines obsolete: They

The hardware that the standards will work on is more powerful and offers greater performance.

***Offering three display options**—a 15-in. color, a 19-in. color, or a 19-in. monochrome monitor—the Apollo Computer Domain Series 4000 workstation is based on a Motorola 68020 running at 25 MHz.*

are alive and well. The Domain Series 4000 Personal Super Workstation from Apollo Computers uses the MC68020 CPU and the MC68881 floating-point coprocessor, both running at 25 MHz. The system memory uses 1M-bit surface-mount dynamic RAMs for a maximum of 32M bytes of main memory, and the system supports as much as 1G bytes of virtual-memory space.

The Series 4000 has an IBM PC/AT-compatible peripheral bus. The CPU runs with zero wait states on an independent 32-bit bus that is fully synchronized with the PC/AT-compatible bus, which holds the system's mass storage, network, and graphics controllers. The 32-bit CPU bus provides a full 32-bit data path between the CPU, cache memory, floating-point coprocessor, and system memory.

***The Macintosh II from Apple Computers** is a 68020-based computer with an open architecture that has six 32-bit Nubus slots for expansion.*

You can either purchase a diskless node, or you can specify a 5¼-in., 1.2M-byte floppy-disk drive; a 60M-byte cartridge tape drive; and either a 155M- or 348M-byte hard-disk drive. You also have a choice of a 19-in., 1280×1024-pixel monochrome display or a 15- or 19-in. color display with a resolution of 1024×800 pixels. The local-area network can be either Ethernet or Apollo's Token Ring.

The Series 3000, which also has an IBM PC/AT-compatible peripheral bus, has gone down in price by as much as 50%, thanks to enhancements in the manufacturing process. A monochrome diskless node has a base price of $4990. The price of a Series 3000 with a 19-in. monochrome monitor, 4M bytes of memory, a 72M-byte hard-disk drive, and a floppy-disk drive is now less than $10,000.

Open architecture means low-cost expansion

Open architecture is a big plus with the Apollo line. Because of the low-cost PC/AT bus, you can use peripheral boards from the inexpensive PC domain to expand the system. You also have the option of plugging in an 80286-based board and running MS-DOS applications.

The newly announced Sun 3/60 workstation uses a 20-MHz MC68020 µP with a 20-MHz MC68881 coprocessor. The Sun 3/260 uses the same processors but operates at a 25-MHz clock frequency. Like Apollo's

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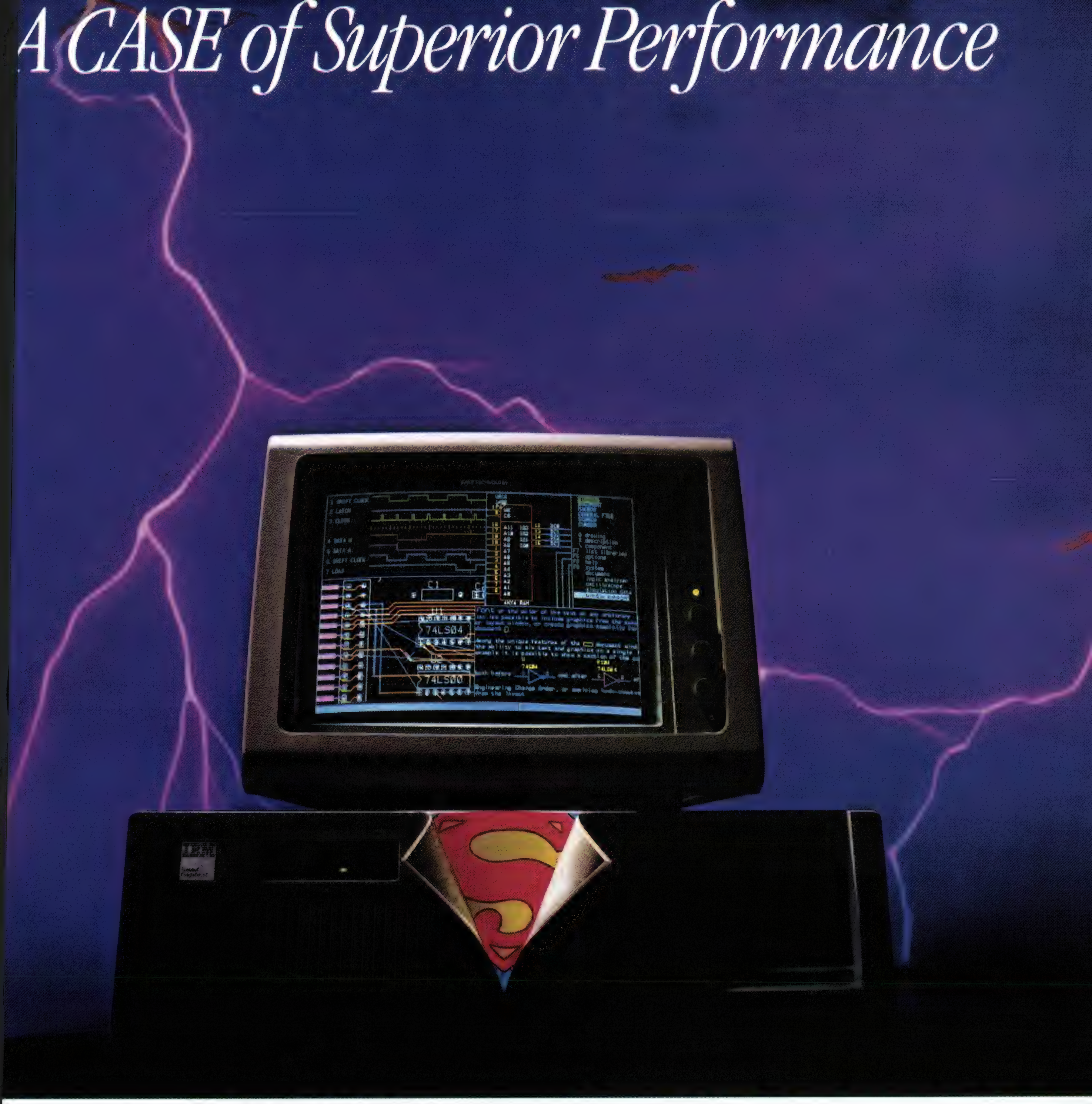

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CIRCLE NO 59

Non-RISC-based workstations are alive and well; in fact, manufacturers are introducing many new products.

Domain Series, some existing members of the Sun 3 family have also seen a significant decrease in price. At the low end, for example, is the Sun 3/50, a diskless node with a base price of $4995.

Digital Equipment Corp manufactures several non-RISC workstations. The VAXstation 3200 and 3500 are recent introductions. Both are based on a proprietary, 32-bit, VAX-based μP made with CMOS technology. The vendor claims that this new CMOS chip set results in performance 2.6 to 4.2 times greater than that of DEC's VAXstation II/GPX. A 1-year on-site warranty is included in the purchase price. The VAXstation 2000, 3200, and 3500 are all software compatible with the other members of the VAXstation family.

The VAXstation 2000 is an entry-level workstation. The lowest-cost version is a monochrome diskless node that sells for $4600. The same system with a 42M-byte Winchester disk drive and a 1.2M-byte floppy-disk drive costs $7650. Designed as a desktop system, the VAXstation 2000 contains a single-board computer with a MicroVAX II μP, a floating-point unit, system memory, disk controllers, a video controller, a mouse, a keyboard, a printer, and serial communication lines. It also has a separate Ethernet controller.

Don't overlook the possibilities of using your personal computer as a low-end workstation. The Apple Macintosh II is a 15.7-MHz 68020-based machine and is the first Macintosh with an open architecture. Six 32-bit Nubus expansion slots support a 10M-byte/sec data-transfer rate. Apple is planning to have Unix available for the Macintosh II in the form of A/UX. A/UX is a full implementation of AT&T Unix System V and includes features from Berkeley's 4.2. The Appletalk network is built into the Macintosh, but an Ethernet interface is available so you can access other machines on your network. The computer's open architecture and massive third-party support provide you with the flexibility to select a configuration that meets your needs.

It's too soon to tell where the IBM PS/2 family will fit in the workstation market. But it's easy to predict that these machines, like the Macintosh systems, will make major inroads into the low-end market.

Regardless of what the future holds, the advantages of having a workstation hooked up to a network of systems all working together and using X Windows can't be overstated. RISC-based workstations have a very easy migration path to higher performance, and gradual improvements in performance will continue. When making your purchasing decisions, insist on a workstation compatible with X Windows, Unix, and Ethernet. Finally, be careful when you evaluate a vendor's estimate of workstation performance and keep your application in mind. **EDN**

***This under-$10,000 color workstation** from Sun Microsystems uses a 20-MHz 68020 μP. The Sun 3/60 offers a choice of five different monitors and has as much as 24M bytes of memory.*

Manufacturers of workstations

For more information on workstations such as the ones discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

Apollo Computer Inc
330 Billerica Rd
Chelmsford, MA 01824
(617) 256-6600
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Apple Computer Corp
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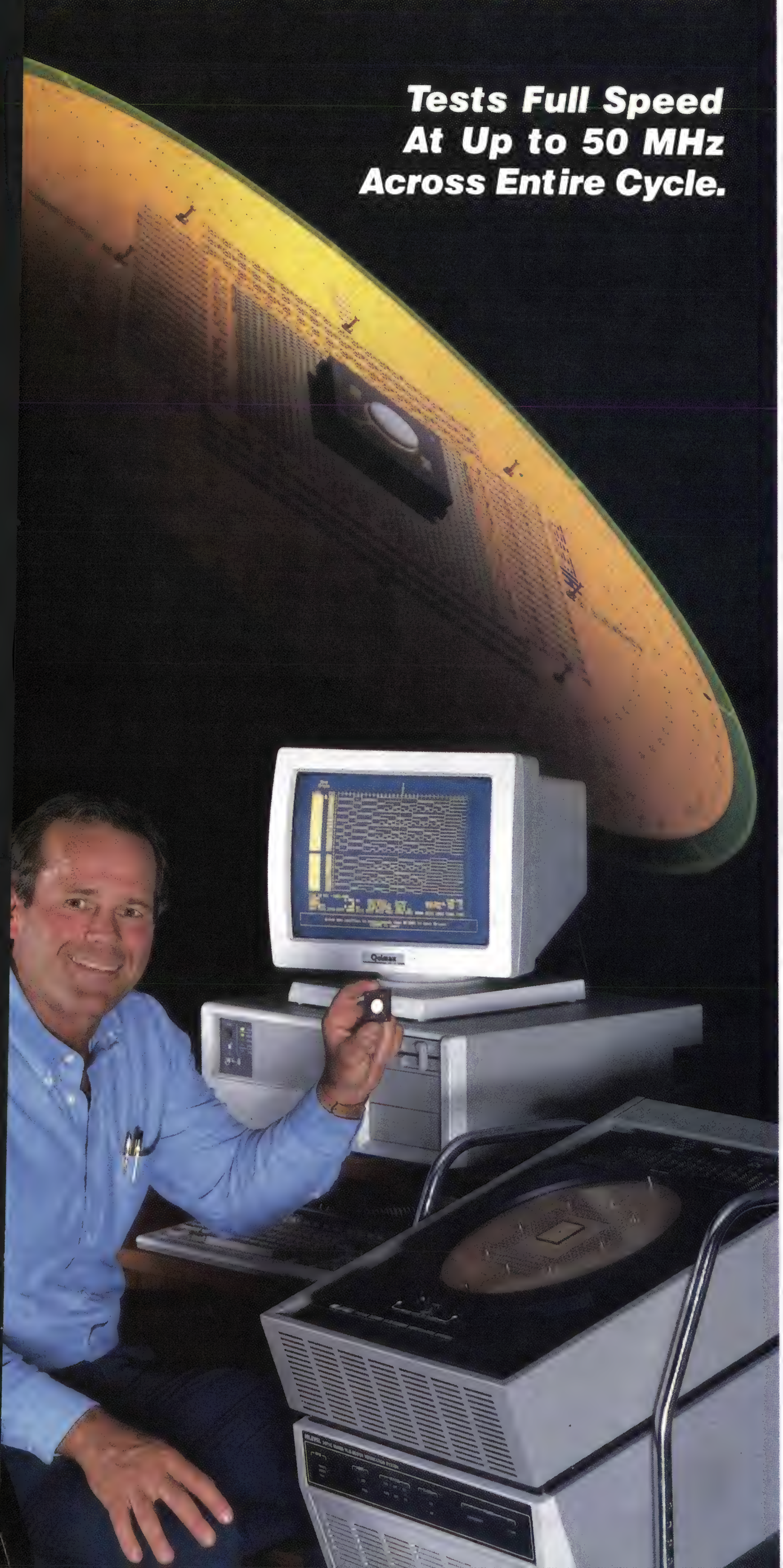

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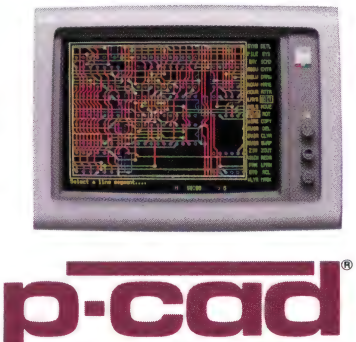

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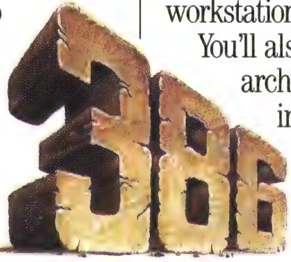

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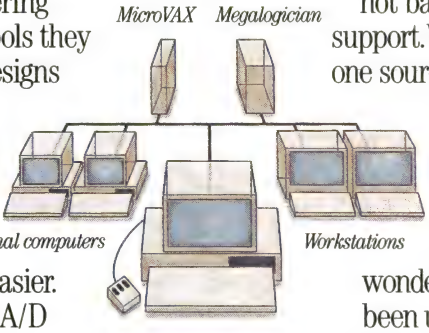

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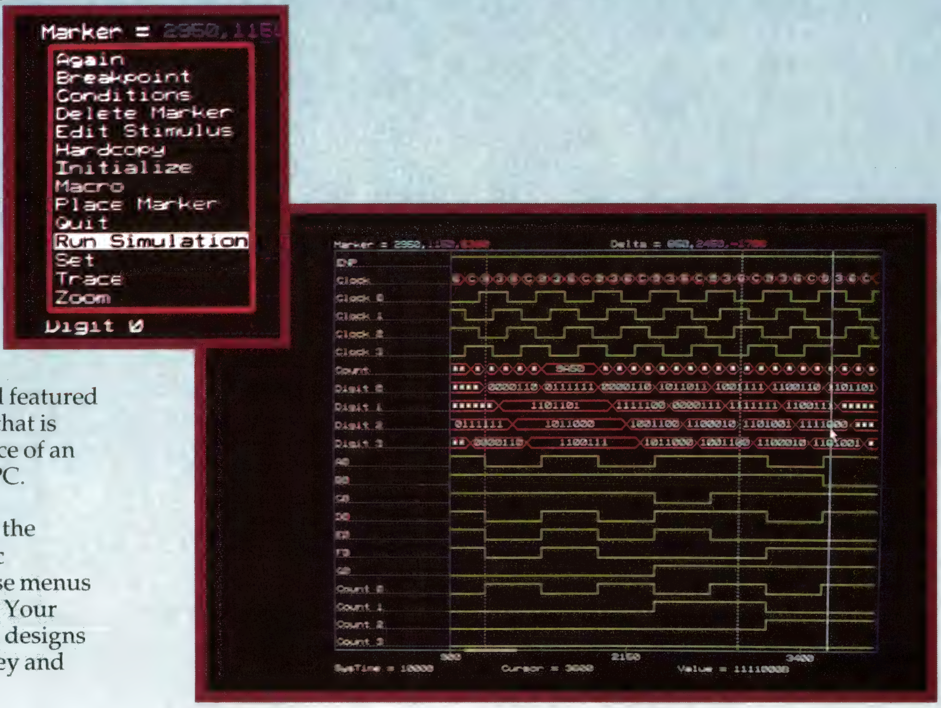

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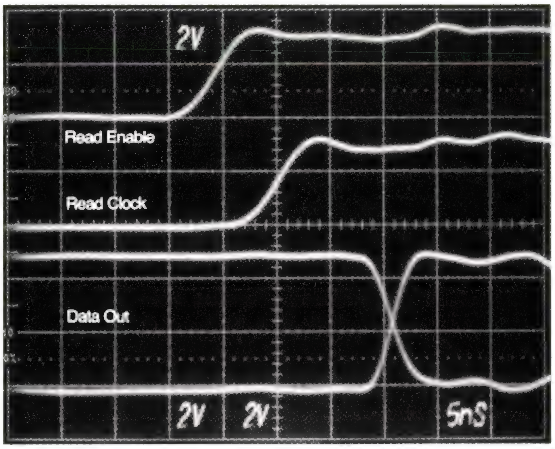
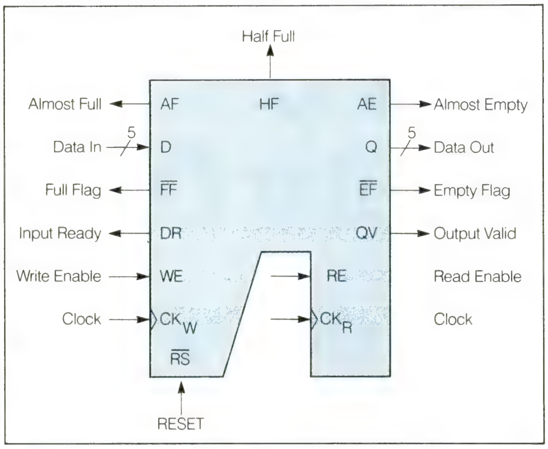


Actual MK4505 BIPORT FIFO Scope Trace Photograph



MK4505M Logic Symbol Diagram

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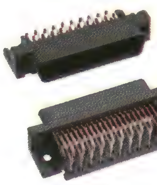

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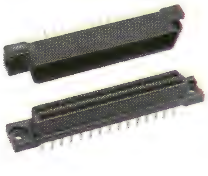

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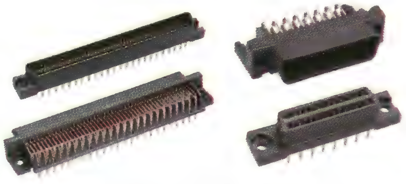

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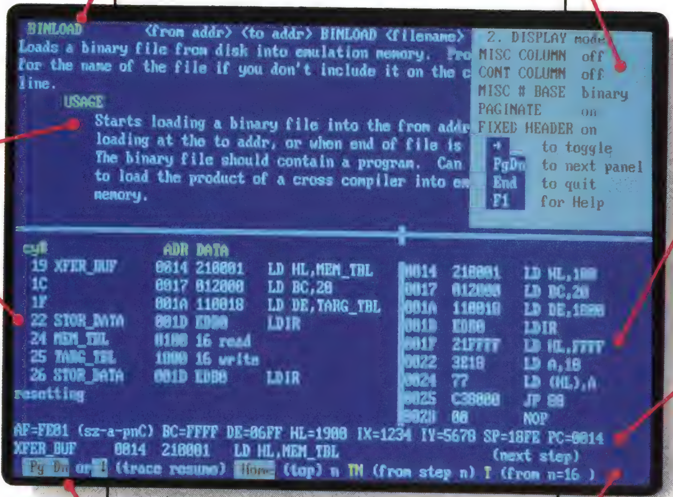

```
BINLOAD          <from addr> <to addr> BINLOAD <filename>   2. DISPLAY mode
Loads a binary file from disk into emulation memory.  Pro  MISC COLUMN   off
for the name of the file if you don't include it on the c  CONT COLUMN   off
line.                                                       MISC # BASE   binary
     USAGE                                                  PAGINATE      on
         Starts loading a binary file into the from addr    FIXED HEADER  on
         loading at the to addr, or when end of file is       →     to toggle
         The binary file should contain a program.  Can       PgDn  to next panel
         to load the product of a cross compiler into em      End   to quit
         memory.                                              F1    for Help

cy#            ADR  DATA
 19 XFER_BUF    0814 210001   LD HL,MEM_TBL    0014  210001   LD HL,100
 1C             0017 012000   LD BC,20         0017  012000   LD BC,20
 1F             001A 110018   LD DE,TARG_TBL   001A  110018   LD DE,1000
 22 STOR_DATA   001D ED00     LDIR             001D  ED00     LDIR
 24 MEM_TBL     0100 16 read                   001F  21FFFF   LD HL,FFFF
 25 TARG_TBL    1000 16 write                  0022  3E18     LD A,18
 26 STOR_DATA   001D ED00     LDIR             0024  77       LD (HL),A
resetting                                      0025  C30000   JP 00
                                               002A  00       NOP
AF=FE01 (sz-a-pnC) BC=FFFF DE=06FF HL=1900 IX=1234 IY=5678 SP=18FE PC=0014
XFER_BUF    0814  210001    LD HL,MEM_TBL                 (next step)
 Pg Dn or ↓ (trace resume)  Home (top) n TN (from step n) T (from n=16 )
```

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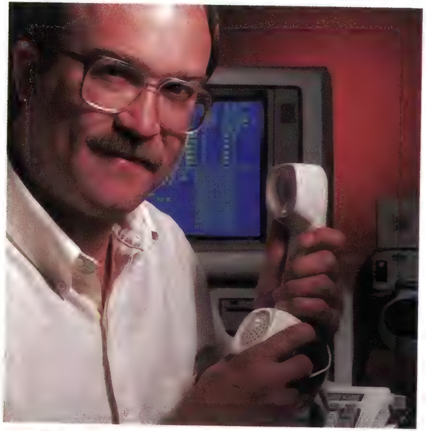

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CIRCLE NO 197

VME Bus applications can benefit from 80386-based designs

Traditionally, designing for the VME Bus automatically meant a design based on a 68000 µP. But without too much trouble you can use an 80386 as a VME Bus CPU.

Steph Rutel and X Kim Rubin, *Force Computers*

Although the first processors designed into VME Bus applications belonged to the 68000 family, there aren't any insurmountable signal or timing restrictions that limit the bus to only these types of processors. The 80386, for example, a 32-bit virtual-memory µP capable of processing 3 to 5 MIPS, can also provide the basis for a VME Bus design. Moreover, the 80386 can execute object code for the 8086 family, which adds to its allure. The device's on-chip resources also allow the chip to intermix operating systems (such as Unix and MS-DOS), which allows you to run application packages as tasks under Unix (see **box**, "Putting the 80386 aboard the VME Bus.")

Multiple bus masters offer advantages

The VME Bus is a high-speed bus that allows you to implement a system that supports data-transfer rates as high as 40M bytes/sec. It also supports multiple bus masters so that you can mix 80386- and 68020-based cards in the same system and take advantage of each of their strengths. For those instances when you want to include more than one master in your VME Bus system, you'll have to include circuitry that will arbitrate between bus masters. Either a round-robin arbitration scheme or a prioritized approach is effective.

Take a close look at the VME Bus standard before considering the 80386 in a VME Bus design. Two standard 96-pin DIN edge connectors, P1 and P2, provide the backplane bus interface. P1 contains all the control lines as well as the lower 24 address and 16 data lines. The middle row of P2 contains the remaining address and data lines, and the two outer rows contain 64 unassigned pins, which system designers can use to define their own functions (see **box**, "VME Bus and 80386 signals are compatible"). The VME Bus's electrical interface requires that the bus drivers' rated drive current is 64 mA for the address- and data-strobe lines as well as for the system-clock and the bus-clear signals. Most of the other lines (including the address and data lines) require only 48-mA drivers.

The critical timing of some onboard signals requires that you include a clock on your board that operates at a much higher frequency than the processor's clock. For instance, you might use a 64-MHz clock as your timebase, which you can then divide by 2 to obtain the 32-MHz signal that the CPU requires. Additional clock phases are distributed on the board so that each drives about the same number of loads, and the signals are about equal in trace length. The combination of limited

Although the first processors to be designed into VME Bus applications were 68000s, the VME Bus isn't confined to just those processors.

trace lengths and equal loading minimizes clock skew. The availability of precision clock signals such as these is crucial to the design of control logic. You can use these master clock signals to synchronize, through gating or latching, all of the control signals (**Fig 1**). This way you restrict the accumulated clock skew to the variation in propagation delay within a chip.

The 80386 accommodates the VME Bus's asynchronous timing via its ready line; the line indicates when outgoing data on the bus is available and valid. The VME Bus's data-acknowledge signal controls the 80386's ready line, thus eliminating the need for any complex clock schemes to synchronize data transfers. This fact isn't surprising, because the 80386's bus is a clocked asynchronous bus that's very similar to that of the 68000 family. The 16-MHz clock that the 80386 requires is identical to the clock required by the VME Bus backplane.

The 80386's remaining signals connect to the VME Bus in a straightforward manner. The data bus is a bidirectional, nonmultiplexed, 32-bit bus. You can buffer it using two 74ALS646-1 dual octal registers, which then connect directly to the VME Bus. (The ALS octal registers provide the required fast switching speed without the noise-inducing edges that some other logic chips have.) You need to generate four control signals (data direction, bus write, latch address, and write mode) for the data bus and four signals for the address bus (latch address, memory address direction, pre-longword, and pre-A01).

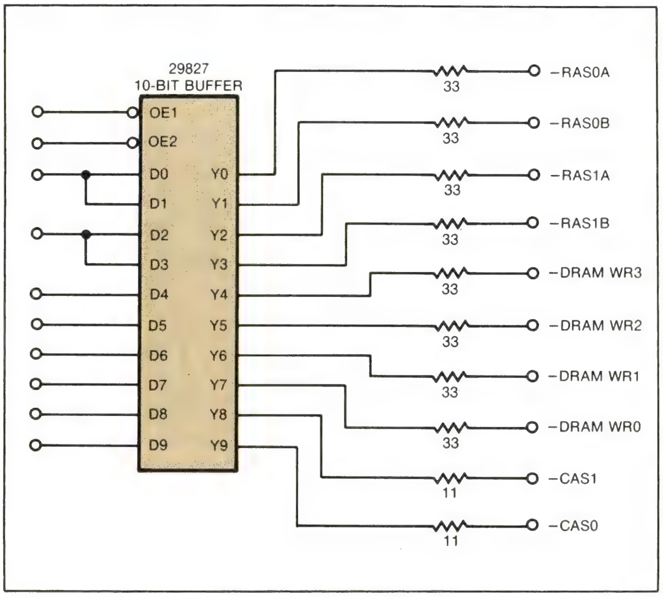


Fig 1—By running all your memory control signals *through the same buffer, you minimize the signals' skew. The termination resistors shown here also minimize reflections on the signal lines.*

You can buffer the unidirectional address bus by using high-current 74ACT374 octal drivers, which latch the address directly from the CPU's bus and connect directly to the board connector. The reason for using latches, rather than buffers, is simple: Very often the system will operate in a pipelined mode for bus accesses and therefore will have to hold the address until the bus is released.

The bus's 32-bit address space is common to both the VME Bus and the 80386, and the VME Bus's A16 address mode supports the 80386's I/O space. The VME Bus supports multiple address spaces, which are controlled by the six address modifier lines. The address space selected depends on whether the access is for I/O,

Putting the 80386 aboard the VME Bus

Force Computers developed a debug monitor for its CPU-386 80386-based VME Bus computer using the company's 68000/020 code as a basis for the development of the 80386 software. Because the 80386 can internally emulate the 8086, it directly executes code already written for the 8086 processor. The only exception to this internal emulation is the initialization and startup utility, which is specific to the 80386. Programs written in native code for the 8086 will run on the 80386, and software written in higher-level languages may be recompiled for the 80386.

The single-board CPU-386 includes three serial ports, two general-purpose RS-232C ports, two 16-bit counter/timers, and three 8-bit counter/timers. All these functions are included in just two chips: the 68901 multifunction peripheral chip from Thomson-Mostek and the 68562 dual universal serial-communications controller-timer chip from Signetics. Front-panel DIP switches set the EPROM type and speed, and these switches also determine the board's boot-up mode.

memory, code, or data, and whether it's a user or supervisory type of access.

A caveat of which you should be aware involves "byte ordering." The 80386 uses a different numbering convention than does the MC68000 family. The 68000 processors' bytes are numbered from left to right (high order to low order) within a long word (32-bit word); the 80386's bytes are numbered from right to left (low order to high order). If you use only one type of processor in a system, the numbering scheme will be inconsequential, but if you develop a system with both types, you must exercise some caution and make sure that you translate low-order to high-order bytes between the processors.

Some VME Bus cycles can take an indeterminately long time to run. In such cases control circuits are necessary to ensure that onboard dynamic RAM cycles don't start while a VME Bus cycle is in progress and that the RAM is refreshed before data is lost. An inhibit signal to the RAM decoder prevents interference between memory cycles and VME Bus cycles. While the RAM decoder is inhibited, another decoder provides VME Bus decoding in parallel with the RAM decoding; the subsequent VME Bus cycle is set up while the RAM cycle is being completed.

The 80386 has a 4G-byte address space. You can load a board with 2M bytes of interleaved, 100-nsec dynamic RAM and yet still obtain zero-wait-state performance **(Fig 2)**. Interleaving divides the memory into two banks and permits one bank to finish its cycle while the other bank is being accessed. If you use look-ahead logic for the interleaved access, the memory can handle data-transfer rates of 32M bytes/sec. To achieve such high rates, the look-ahead feature must examine the current state of the system and decide which of several combinatorial paths to follow next. By selecting the combinatorial path in advance, the timing section only encounters the delay caused by the combinatorial logic.

Another technique you can use to accelerate memory accesses is transparent memory refresh—a technique that eliminates interference between the processor and the refresh function. Your refresh circuitry must access the dynamic RAM only when the RAM is idle, when the processor isn't trying to read from or write to memory. You can use a few programmable logic chips to generate the necessary refresh logic. It's a good idea to buffer all the RAS (row address strobe) and CAS (column address strobe) signals with the same chip to minimize the skew between those signals. You should also use termination resistors on these signal lines; the signals will be distributed to many chips on your board, and the termination resistors will eliminate signal-quality problems such as reflections.

You can base your RAM-control logic on a state-

VME Bus and 80386 signals are compatible

Using the 80386 in a system originally designed for the 68000 requires only a minimal amount of head scratching as far as control signals are concerned: Buses are buses, after all. Many of the control signals that the 68000 Series uses have equivalents on the 80386, or you can reconfigure 80386 signals using glue logic to generate the appropriate equivalent.

The 80386 comes in a 132-lead pin-grid array package. If you eliminate the 21 V_{CC} pins, the 20 ground pins, and the eight unconnected pins, you have 83 signal pins. The data bus uses 32 pins, and Intel's expansion of the lower two address bits into byte-enable lines produces a total of 34 address lines. Subtracting the data and address pins' total from 83 leaves 17 control and status signals to deal with.

Like most μPs, many of those 17 pins have standard functions —for example, single-phase clock, reset input, nonmaskable interrupt, and general interrupt. Hold and hold-acknowledge signals on the 80386 provide the necessary handshaking for you to get the processor on and off the bus. The signals that are specific to the memory interface are the read/write and address-strobe lines and the memory/IO lines. Another line, data/code, indicates whether the processor is pulling an instruction or data word from the bus.

One more control signal, "bus size 16," tells the processor that it should use a 16-bit, rather than a 32-bit, data bus. The busy output permits the processor to indicate to the rest of the system that it can't respond to a bus access.

The VME Bus supports multiple bus masters, so that you can mix 80386- and 68020-based cards in the same system.

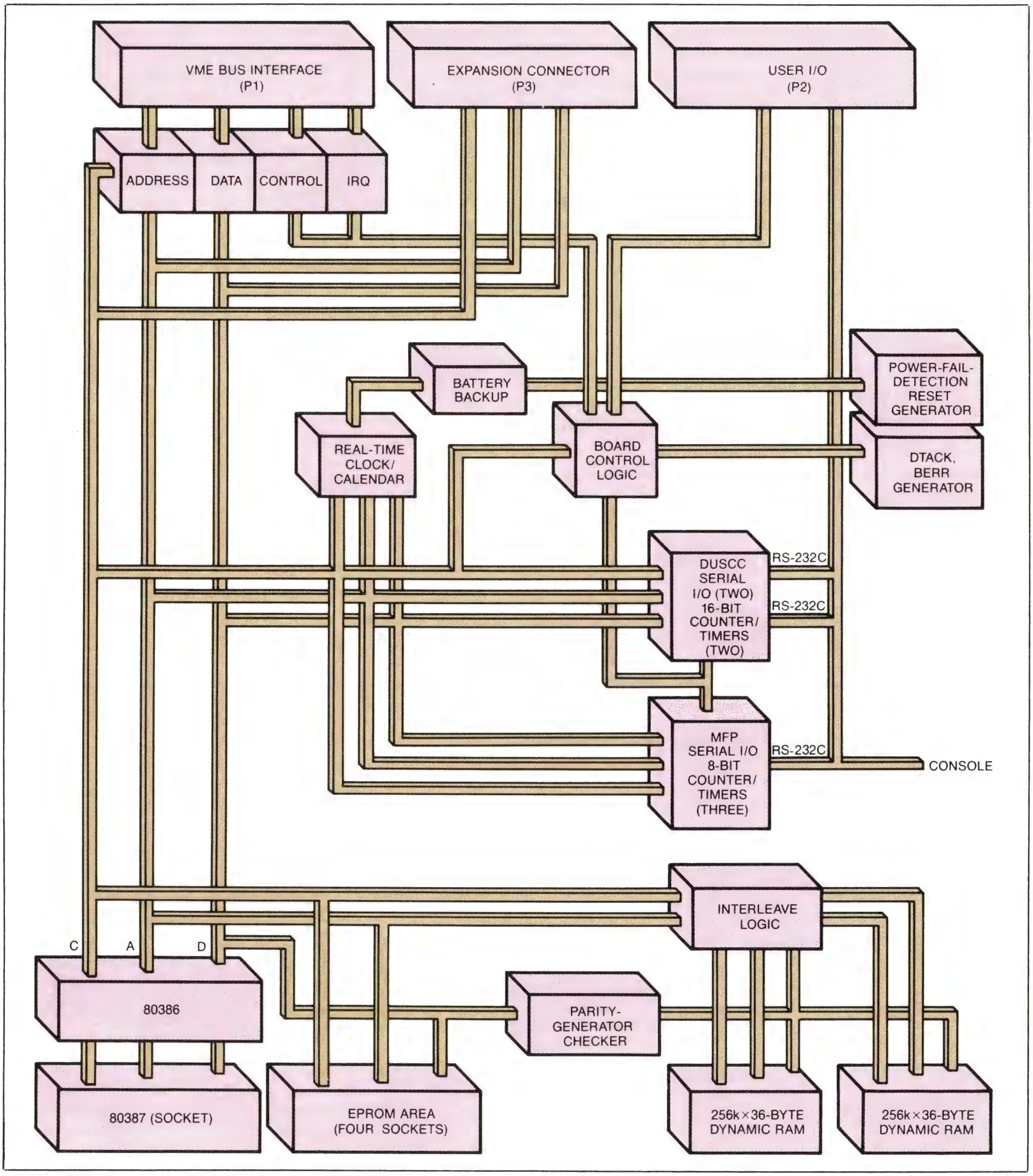


Fig 2—This diagram of an 80386-based VME Bus board's architecture *illustrates, among other things, the interleaved RAM that provides zero-wait-state operation.*

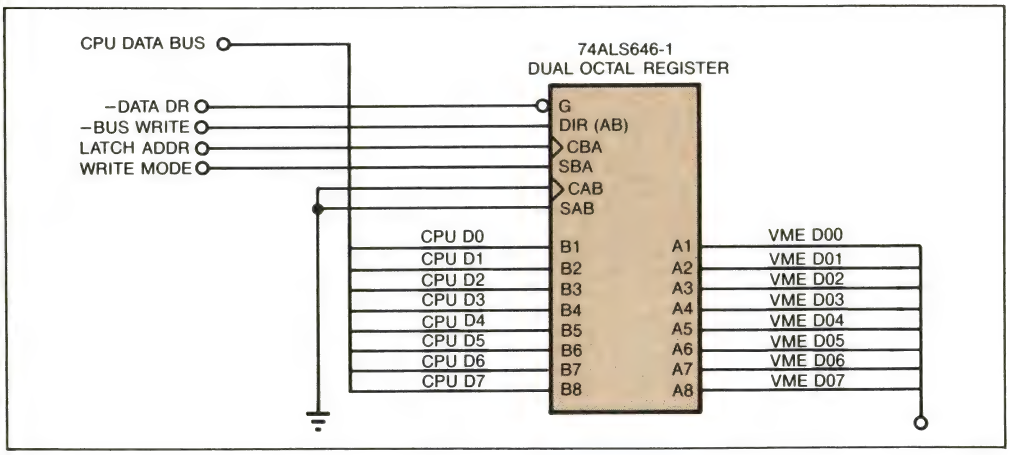


Fig 3—Using an octal register *for all the VME Bus address and data lines allows you to pipeline data acquisition.*

machine sequencer. The basic machine consists of nine states, though there are additional substates. One of the nine states is an idle state; four others control each bank of RAM; and four more control the refresh operation. Of the four states that control each bank of RAM, each state corresponds to a single cycle of the 16-MHz clock. The first two states represent the access, and the next two states represent the recovery states, which guarantee that the minimum cycle time requirement for the chips in each bank isn't violated. If the memory banks are accessed alternately, which happens for consecutive accesses, then only the first two states are needed because another access starts in the other bank while the previously accessed bank finishes its cycle. Although four states are available to control the refresh operations, two more idle states must be injected if the refresh logic requests a high-priority refresh.

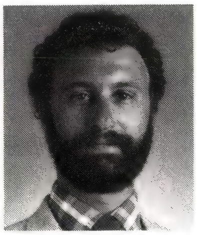
You might think, from the above description, that only those instruction streams that consist entirely of consecutive instructions will run without wait states. However, because the 80386 can't process changes to its execution flow as fast as it processes consecutive instruction fetching (due to its on-chip 16-byte prefetch queue), it must pause when it encounters a jump instruction and generate a new address (the queue is flushed and refilled with information pointed to by the new starting address). This pause gives the memory banks a chance to complete the current cycle, which allows the processor to jump to either bank without a wait state. The processor's pause isn't considered a wait state because it is internal to the µP; this design uses the pause opportunistically to refresh the memory.

Using pipelining techniques, you can accelerate the execution of bus operations (**Fig 3**); that is, as a data transfer is being completed, you begin broadcasting the next address. The VME Bus allows you to assert the address lines with as little as a 2-clock-cycle delay from the previous address cycle.

You can accomplish pipelining in two ways. The address for the next cycle can be placed on the VME Bus immediately following the assertion of the DTACK signal, overlapping the end of one bus cycle and the beginning of another. You can also use look-ahead logic to allow the board to retain control of the bus in those instances when the next CPU cycle is also going to require control of the VME Bus; this method eliminates the bus request/grant operation's overhead. **EDN**

Authors' biographies

Steph Rutel is manager of product marketing at Force Computers in Los Gatos, CA. He received his BSEE from Arizona State University and previously worked as a consultant. Steph enjoys the outdoors and particularly likes to hike and fish.



X Kim Rubin is Force Computers' director of engineering. He received his BSEE/CS from the University of California at Berkeley. He belongs to the IEEE and holds several patents.

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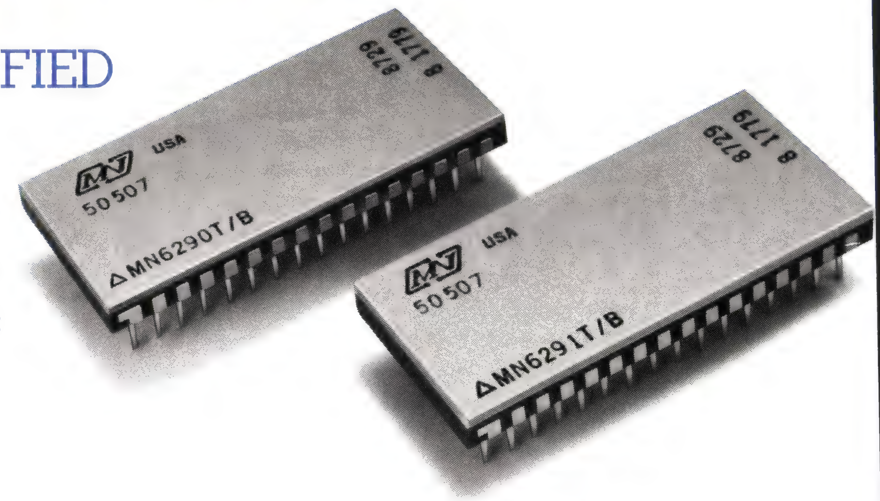
MN6000 Series

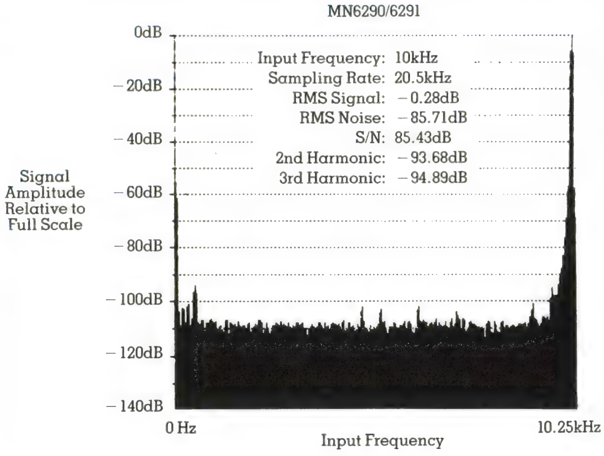
Single Package Sampling A/D's
User Transparent T/H Amplifiers
Frequency Domain (FFT) Testing
High Sampling Rates/Resolution:
    MN6290/6291: 20kHz 16 Bits
    MN6231/6232: 50kHz 12 Bits
    MN6227/6228: 33kHz 12 Bits
MIL-STD-883 Screening

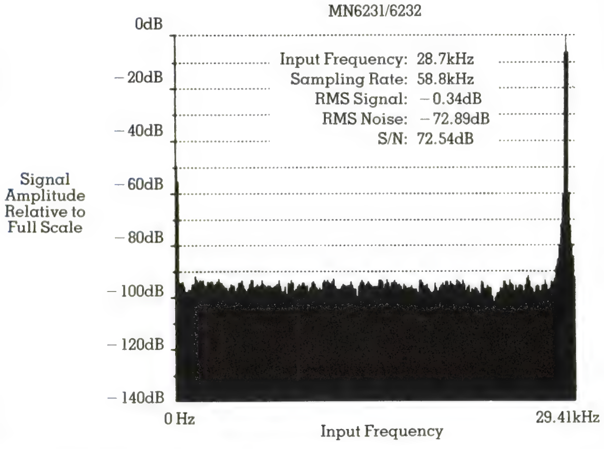


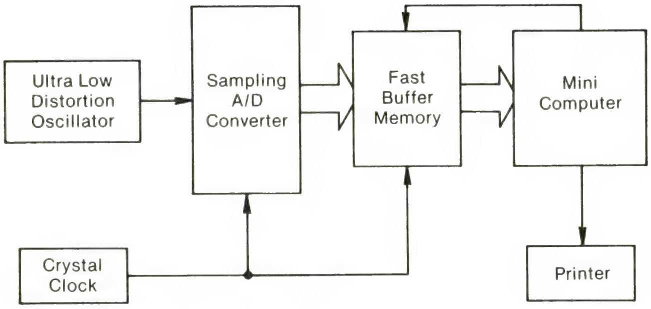
For you, we've expanded our line of FFT-tested, high-speed, sampling A/D converters with two new 16-bit models: MN6290 and MN6291. Like our entire MN6000 Series, these new devices mate a track-and-hold amplifier (T/H) with a high-speed, high-resolution, A/D converter in a single DIP package. The T/H is completely transparent, eliminating the hassle of evaluating T/H specs that are difficult to understand and often don't relate.

All MN6000 devices accurately sample and digitize dynamic input signals with frequency components up to the Nyquist frequency (one-half the sampling rate). They are ideal for radar, sonar, spectrum and vibration analysis, voice and signature recognition, and other contemporary DSP applications. All come with full frequency-domain performance specifications, which are critical to designing for these applications.

Micro Networks was the first to apply FFT testing to A/D converters. We recognized that this would be the key to specifying A/D's for emerging DSP applications. In our frequency-domain testing, sampling A/D's operate in a manner that simulates a digital spectrum analyzer with a known low-distortion input signal. The output spectra yield precise, practical measurements of signal level, noise level, signal-to-noise ratio, harmonic distortion, and input bandwidth, giving you the performance specifications you need to design to your application. Our testing clearly demonstrates the ability of our MN6000 Series devices to maintain near-ideal signal-to-noise ratios independent of increasing analog input frequencies.







Frequency-Domain Testing of A/D Converters

All MN6000 Series devices are packaged in standard ceramic DIP's and are available fully specified for −55°C to +125°C with MIL-STD-883 screening. 12-bit models contain full 8 or 16-bit μP interfaces. Select the device that best meets your design requirements.

Part Number	Input Range	Minimum Sampling Rate	Minimum Input Bandwidth (Note 1)	SNR (Note 2)	Harmonics
12-Bit Resolution					
MN6227	10V	33kHz	16.5kHz	70dB	−80dB
MN6228	20V	33kHz	16.5kHz	70dB	−80dB
MN6231	10V	50kHz	25kHz	70dB	−80dB
MN6232	20V	50kHz	25kHz	70dB	−80dB
16-Bit Resolution					
MN6290	10V	20kHz	10kHz	84dB	−88dB
MN6291	20V	20kHz	10kHz	84dB	−88dB

1. Input bandwidth for which SNR and harmonic specs are guaranteed when sampling at the minimum guaranteed rate.
2. Signal-to-noise ratio (r.m.s. to r.m.s.) with full-scale (0dB) input.

For detailed information on MN6290/6291 or other high-speed sampling A/D's in our expanding line, send for our comprehensive data sheets. For rapid response, call Russ Mullet at Ext. 208.

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CIRCLE NO 198

Type 8812 computerized cash register keyboard and line display housing made of Bayblend

If you're looking for the right material, why not do as Nixdorf's design engineering department did: talk to Bayer!

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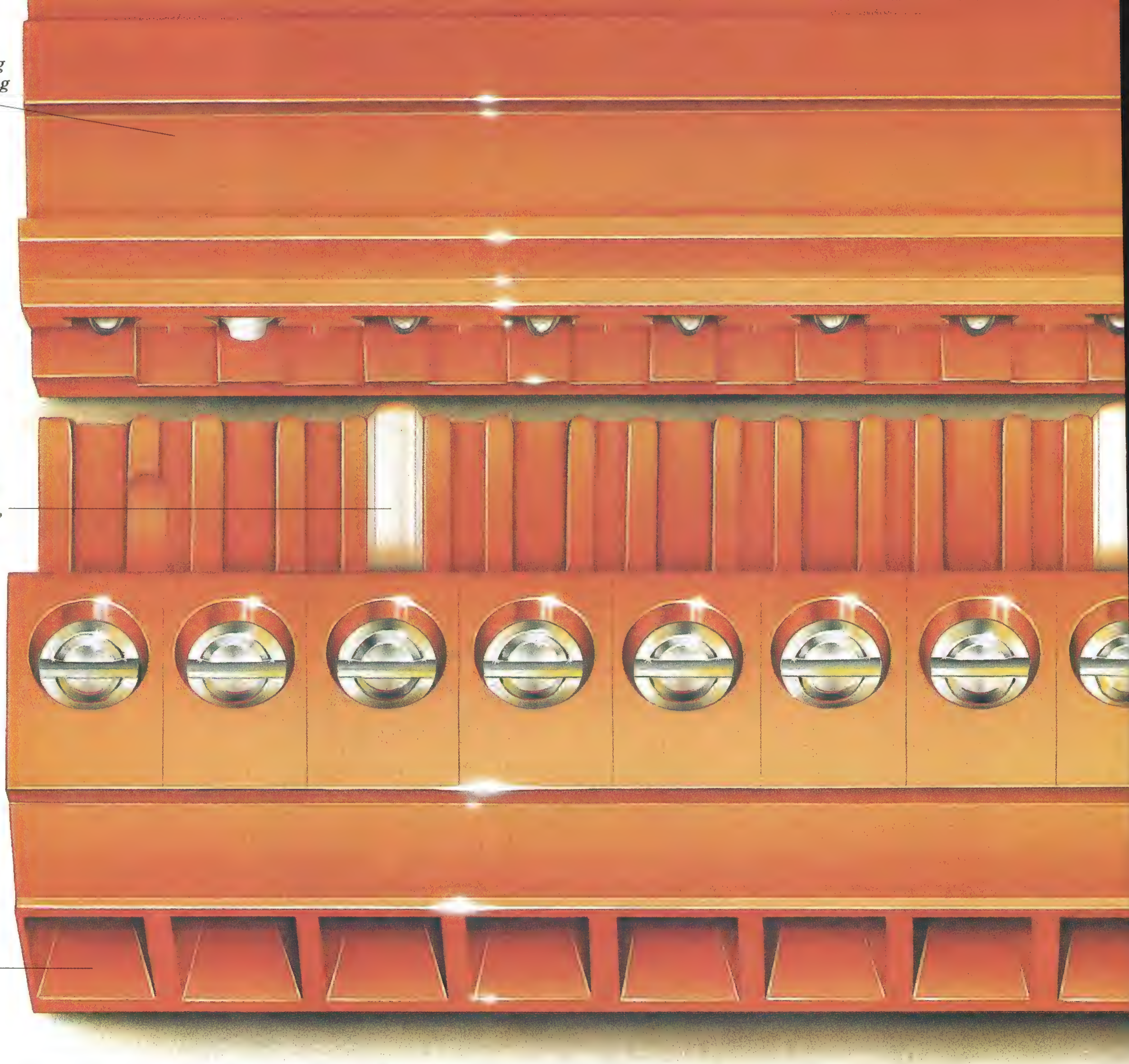
CIRCLE NO 159



Large, angled marking surfaces for easy labeling and readability.

Coding system protects against misconnection, without loss of poles.

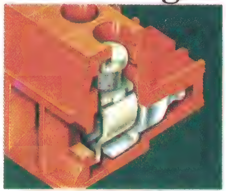
Funnel-shaped entry for easy installation of wiring.

EVEN THE COL

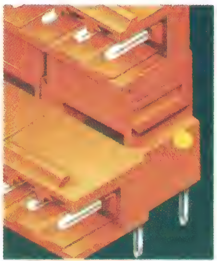
Introducing the Weidmuller BLA/SLA Plug and Socket Connector System.

For years Weidmuller terminal blocks and connectors have set standards all over the world in electrical and electronic connection systems. Now our design engineers have come up with another brilliant solution. Our compact new BLA/SLA System for machine and process control circuit boards.

Our new design makes it quick and easy to install and repair wiring at the factory and in the field without expensive tools. Refinements include funnel-shaped wire entries, captive screws, and an improved zinc-plated steel clamping mechanism for a secure connection.



Vibration-proof clamp design for easy wire installation and removal.



Double header version available for increased wiring density.

The glass-filled polyester insulating material of BLA/SLA connectors is non-burning (UL94V-O) and heat and humidity resistant to maintain pin-to-pin spacing in adverse operating environments.

Marking surfaces on the sockets are large and angled for

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Available in 2 to 24-pin vertical and horizontal configurations.
Captive screws.

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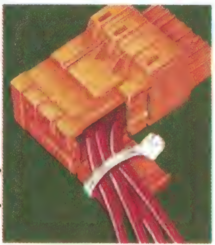
ease of labeling and reading.

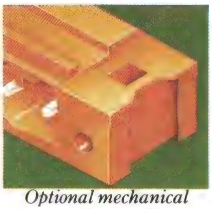
The design of BLA/SLA connectors prevents misalignment. And, thanks to our simple new coding system, the BLA/SLA System provides protection against misconnection of plug and socket when you're using more than one connector. All without loss of poles.

Weidmuller BLA/SLA connectors come in 2 to 24-pole modules and in vertical and horizontal configurations. A doubleheader version is available for those applications requiring even greater wiring density.

With so many standard features and with options like supplementary mechanical mounting blocks and strain relief covers, we're confident you'll find our new system the best available for connecting wiring to circuit boards.

Call or write for more information about the BLA/SLA. A system whose brilliance you'll appreciate even if you're color-blind.


Optional cover with strain relief.


Optional mechanical mounting provides additional stability.

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CIRCLE NO 105

Your next destination:

The ACL Computer Age.

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LM2931	Low dropout, low quiescent current, 5 V or adjustable, 100 mA
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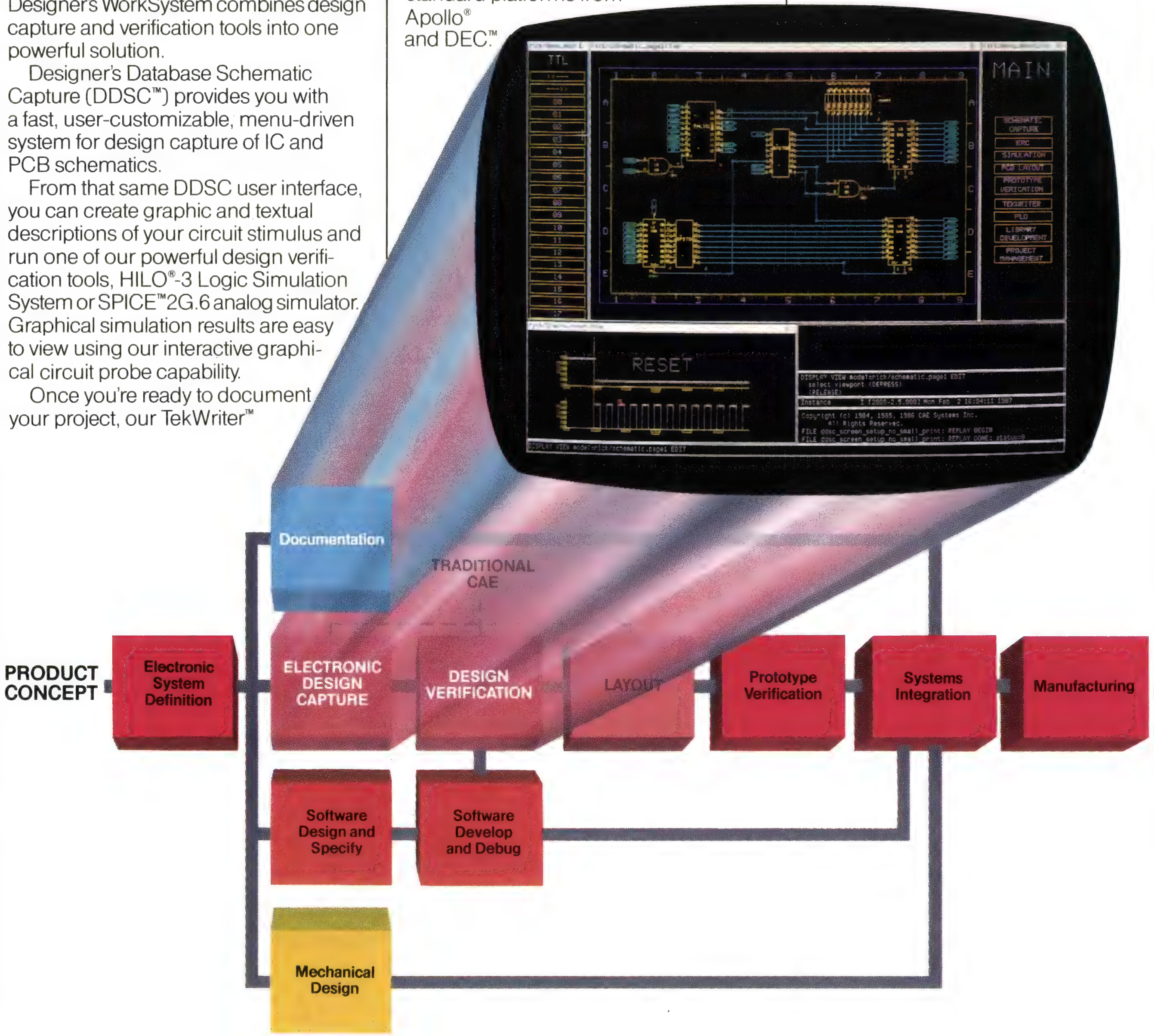

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  select viewport (DEPRESS)
  (RELEASE)
Instance          I [2860-2.5.000] Mon Feb  2 16:04:11 1987
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FILE ddsc_screen_setup_no_small_print: REPLAY BEGIN
FILE ddsc_screen_setup_no_small_print: REPLAY DONE: status=0
```

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CIRCLE NO 103

FET op amps convert photodiode outputs to usable signals

Because FET op amps have low input currents, circuit designers almost universally employ them to monitor the outputs of most photodetectors. Your choice of an amplifier and circuit connection for use with a photodetector depends on the linearity, offset, noise, and bandwidth specs your application requires.

Jerald Graeme, *Burr-Brown Corp*

Instruments that gather data remotely, without contact with the measured object—such as CAT scanners, star-tracking instruments, and electron microscopes—depend on light for linking the received signals with signal processing. Photodetectors act as the bridge between a basic physical indicator and the subsequent electronic processing of the received signals.

Photodetectors use photodiodes, as well as FET op amps and other circuitry, to convert light energy to electrical energy. The accurate conversion of the photodiodes' output to a linear electrical signal is a contest between speed and resolution, and noise is a basic limiting factor in this contest. Central to the contest is the current-to-voltage converter, which seems simple but exhibits surprising constraints, such as noise amplification and difficulty in maintaining dc stability. You can optimize the performance of the current-to-voltage converter, and thus facilitate accurate signal conversion, by choosing the right op amp for your application and by using one of a number of circuit configurations.

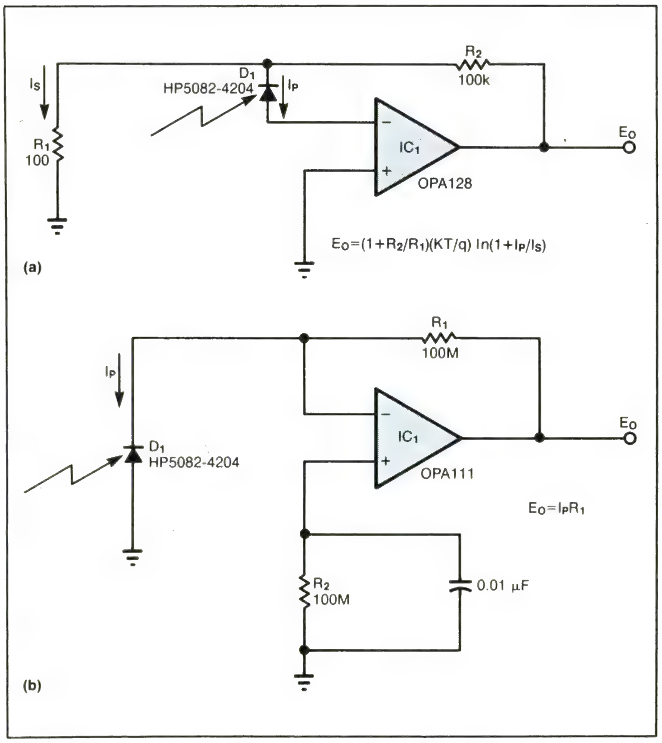

***Fig 1—You can monitor the output of a photodiode** as a voltage **(a)** or as a current **(b)**. Although the first technique is a common one, it has a drawback: The voltage mode is nonlinear.*

The light energy transmitted to a photodiode produces an output that you can measure as either a voltage or a current. When you measure the output as a voltage, you must monitor the diode from a high impedance that does not draw a significant amount of signal current. The circuit shown in **Fig 1a** provides such a condition; the photodiode is in series with the input of an op amp where (ideally) zero current flows. The op amp's feedback, set by R_1 and R_2, determines the

The accurate conversion of photodiode output to a linear electrical signal is a contest between speed and resolution, and noise is a basic limiting factor.

amplification of the diode voltage as though this voltage were an offset voltage of the amplifier. Although this technique is common, it has a drawback: The voltage mode is nonlinear. Because the diode's sensitivity varies with its voltage, its response has a logarithmic relationship to the light energy it receives.

To obtain a constant voltage for a fixed sensitivity, you should use the current-mode approach, in which the diode's response is linearly related to the incident light energy. A diode-current monitor must have zero input impedance to be able to respond with no voltage across the diode. You can obtain zero impedance by using a configuration like the one shown in **Fig 1b**. The op amp's virtual ground provides zero impedance because the high loop gain of the amplifier removes any voltage swing from the input. **Fig 1b**'s circuit provides an input resistance of R_1/A, where A is the open-loop gain of the op amp. Even though R_1 is generally very large, the resulting input resistance is negligible in comparison with the output resistance of photodiodes.

Because of the very high input impedance of the op amp, diode current flows only through feedback resistor R_1. This current forces the amplifier to develop an output voltage that is equal to the diode current times the feedback resistance. For the current-to-voltage gain to be high, R_1 must be as large as other constraints will permit. At higher resistance values, R_1 begins to develop a significant thermal dc-voltage drift caused by the temperature coefficient of the amplifier's input current. To compensate for this error, you'd typically connect a resistor of equal value (R_2) in series with the op amp's noninverting input, and then capacitively bypass this resistor to remove most of its noise. The mismatches between the amplifier's input currents and between the two resistors determines the remaining dc error.

A drawback of this error-correction method is that it creates a voltage drop across the diode, which results in diode leakage current. Photodiodes typically have a large junction area (which gives them high sensitivity); the leakage current is proportional to the diode area. This leakage current can become much larger than the op amp's input currents and can override the correction achieved by R_2.

Watch out for parasitic capacitance

Although a diode voltage of zero can eliminate leakage current as an error source, the zero diode voltage inhibits your control of another effect of large diode area—large parasitic capacitance, which can often cause severe amplification of noise. To reduce this capacitance, you can impress a large reverse-bias voltage on the diode, but doing so greatly complicates dc stability and makes the current noise from the photodiode an additional error factor. In sum, a large diode area may actually degrade the diode's overall accuracy, so you should try to obtain higher photosensitivity in photodiodes through optical means, such as using a package with an integral molded lens.

The value of the feedback resistor in a current-to-

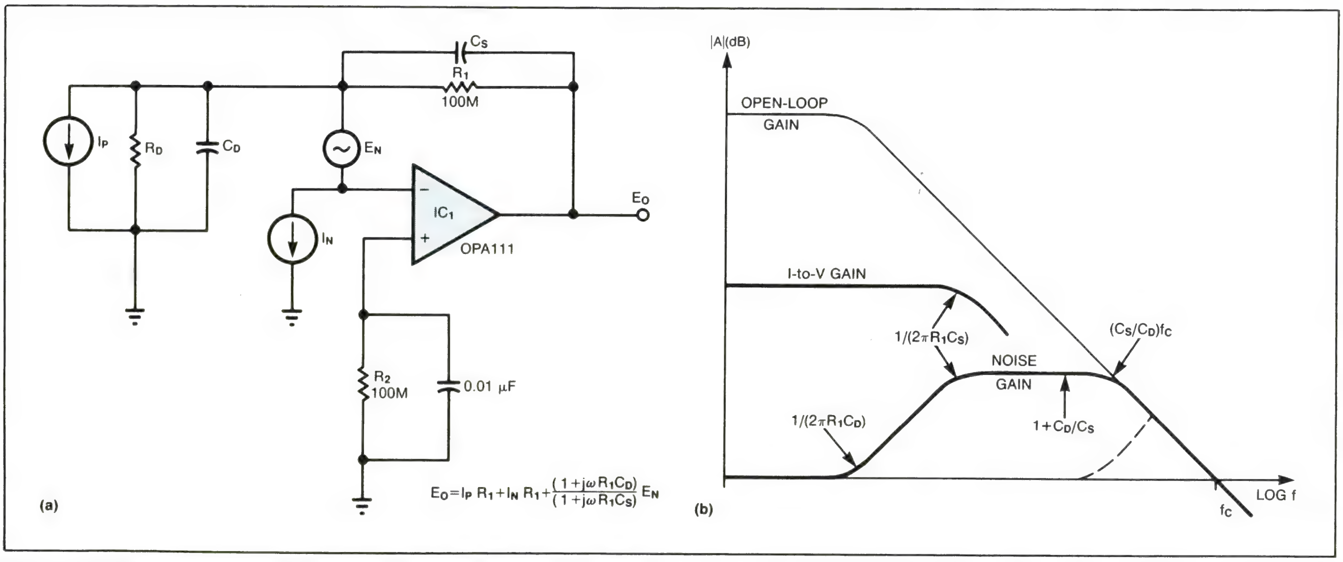

Fig 2—Diode capacitance in the feedback path *of the basic current-to-voltage converter* ***(a)*** *allows the op amp to provide gain and bandwidth* ***(b)*** *that's not available to the signal.*

voltage converter largely determines the noise and bandwidth as well as the gain. Resistor noise has a spectral density of $\sqrt{4KTR}$, and it appears directly at the output of the converter without amplification (**Ref 1**). Increasing the size of the resistor raises the output noise by $\sqrt{4KTR}$, but also increases the output signal in direct proportion to the increase in resistance. As a result, the signal-to-noise ratio tends to increase by the square root of the resistance.

Besides the diode's capacitance, a high value of feedback resistance can also influence the noise output of the op amp to a surprising degree. The amplifier-noise sources shown in **Fig 2a** include the input noise current (I_N) and the input noise voltage (E_N). The noise current flows through the feedback resistor and experiences the same gain as the signal current does. The noise current is the shot noise of the input bias current, I_B, and it has a noise density of $\sqrt{2QI_B}$ (**Ref 1**). If you choose an op amp having input currents in the picoamp range, this noise component will be negligible for practical values of feedback resistance.

The input noise voltage is another matter. At first glance, it might seem that the amplifier, with low gain, would transfer this noise voltage to the output. The gain is indeed kept small at dc (gain$=1+R_1/R_D$) by the large diode resistance (R_D); however, at higher frequencies, the capacitance of the diode (C_D) alters the feedback, adding a significant amount of gain to E_N.

Because both the capacitance and the feedback resistance are usually large, the feedback effect can begin at fairly low frequencies. **Fig 2b** illustrates this effect by showing an op-amp gain curve plotted with the reciprocal of the feedback factor, or the "noise gain." The gain curve first experiences a zero response to C_D and then begins a rise that is terminated because of a second parasitic capacitance. Stray capacitance (C_S) shunts the feedback resistor, resulting in a response pole that levels the gain at $1+C_D/C_S$. For large-area diodes, C_D can be hundreds of picofarads and can cause the noise gain to peak at a high level. The gain continues to higher frequencies until the op amp's bandwidth limit rolls it off. As the feedback resistance increases, the pole and zero of this gain-peaking phenomenon move together to lower frequencies, encompassing a greater spectrum at high gain.

The first signs of this gain-peaking phenomenon will be familiar to anyone who has used high-resistance op-amp feedback in more general circuits. High output-to-input resistance in circuits containing op amps results in overshoot, response peaking, poor settling, and sometimes even oscillation—all because of the resistance interaction with the amplifier's input capacitance. Together, the resistance and capacitance form another pole in the feedback loop, resulting in the classic differentiator feedback response.

As the dashed line in **Fig 2b** shows, in more general op-amp cases, the associated feedback-factor reciprocal intercepts the amplifier's open-loop magnitude response with a 12-dB/octave rate of closure, which corresponds to a feedback phase shift that approaches (or is equal to) 180°. The common cure for this condition is to have some capacitance across the feedback resistor. For the very high resistances commonly used in current-to-voltage converters, the stray capacitance automatically takes care of this need. Such capacitance degenerates the added feedback pole to control phase shift in the feedback loop.

All frequency responses are not equal

To understand the noise performance of current-to-voltage converters, you must note that the signal current and the noise voltage encounter entirely different frequency responses. The current-to-voltage gain remains flat with frequency until the stray capacitance rolls off the feedback impedance, as shown in **Fig 2b**. The gain received by the amplifier's noise voltage, shown on the same graph, extends well beyond that roll-off and is high in that extended region. The greater part of the op amp's bandwidth often serves only to amplify the noise error, not to amplify the signal. This characteristic is typically the dominant source of noise for higher feedback-resistance values.

Fig 3 illustrates the relative effects of the major noise sources of a current-to-voltage converter. These curves show the output noise for **Fig 1b**'s basic current-to-voltage converter and the effects of the noise gain represented in **Fig 2b**. The curves in **Fig 3** plot the total output noise as a function of feedback resistance for three different cases. Each curve is the rms sum of the components produced by the feedback resistor and an op amp. Each of the three examples uses a different FET op amp.

Each op amp is optimized for a different performance characteristic useful in photodiode applications. Although all three types are low-noise designs and have low input currents, the OPA111/OPA2111 offers the lowest noise—6 nV/$\sqrt{\text{Hz}}$—and the OPA128 has the lowest input current—0.075 pA. The OPA404 design has a 6.4-MHz bandwidth. For the graph, the noise caused by the op amp was found by integrating the

The value of the feedback resistor in a current-to-voltage converter largely determines the circuit's gain, bandwidth, and noise.

amplifier's noise-density spectral response over the noise-gain response **(Ref 2)**. The dashed line shows the noise caused by the resistor alone for the OPA111/OPA2111. This resistor's noise curve is different for the other op amps, because each amp has a different bandwidth that rolls off the noise caused by the resistor.

Different factors control the noise curves for different ranges of feedback resistance. At low values of resistance, the noise curves are essentially flat; the op amp's voltage noise is the dominant contributor. That dominance prevents any initial increases in resistance from having much effect, except in the case of the OPA111/OPA2111, with its very low voltage noise. In this low-resistance region, noise gain peaking is not a factor, and the output noise remains small. Between 10 kΩ and 1 MΩ, resistor noise dominates, and the curves track that error source (as the dashed line in **Fig 3** shows) for the OPA111/OPA2111. Here, the curves demonstrate the square-root relationship with the resistance; they differ only because of amplifier bandwidths.

At still higher resistance values, noise gain peaking takes effect, returning the op-amp noise to dominance and boosting the curves higher. This effect is first demonstrated by the increased slope of the OPA404 curve, which rises into the gain-peaking range, then levels off.

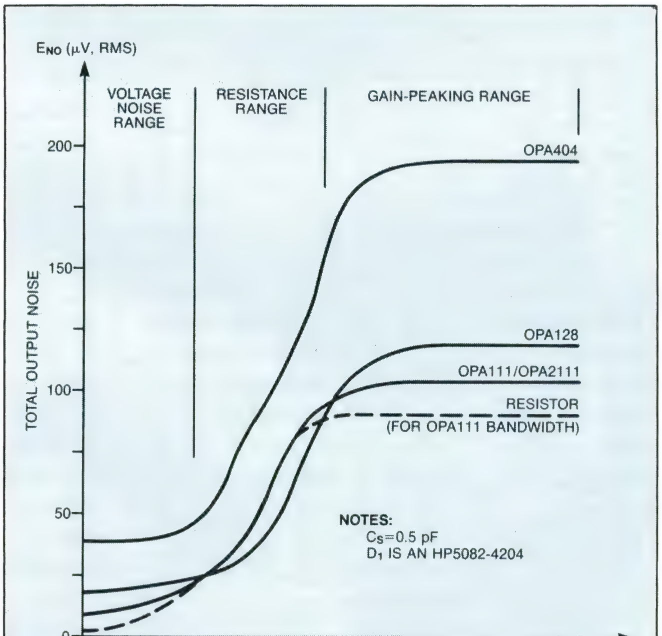

Fig 3—As the feedback resistance of a current-to-voltage converter increases, *the dominant noise source changes from the op amp to the resistor and back to the op amp under gain-peaking conditions.*

At even higher resistances, resistor noise would return the curves to rising slopes, except that stray capacitance rolls off the resistor bandwidth. In this upper region, any increase in resistance is accompanied by a matching reduction in resistor-noise bandwidth, so the total resistor noise becomes a constant. Diode- and stray-capacitance variables alter the onset point of gain-peaking errors, but the characteristic shape of the output noise curves remains the same. Each curve displays ranges that are dominated by op-amp noise, resistor noise, or gain-peaking effects.

Comparing the response curves

A comparison of the curves shows that the OPA111/OPA2111 provides the lowest noise in two of the characteristic ranges. The OPA128 has a lower noise curve in the middle range as a result of its lower bandwidth. Where the OPA128 excels is in low dc error, which results from its very low (0.075-pA) input currents. The third op amp, the OPA404, produces higher total output noise, but this noise is also largely a bandwidth phenomenon. The 6.4-MHz response of the OPA404 amplifies noise over a much greater frequency range. Although the noise curve for the OPA404 amplifier is consistently higher than that of the OPA128, the OPA404 actually has lower noise density. However, the OPA404's 6.4-MHz bandwidth (six times that of the OPA128) is available with circuit feedback resistances as high as 50 kΩ, and that bandwidth is still best for resistances as high as 150 kΩ.

Only a 5-dimensional graph could display the output noise, resistance, dc error, diode area, and signal bandwidth that you must consider when you design current-to-voltage converters. You need to evaluate the requirements of each specific application separately. To optimize a given design for a single factor (such as gain, for example) you must anticipate the various effects of increasing the feedback resistance at each step. When you choose the size of the diode area, for example, you must consider the related capacitance and its effect on the output noise and the overall circuit sensitivity.

As mentioned, gain-peaking effects are the primary cause of noise problems in circuits that have high values of feedback resistance. To limit gain-peaking effects, or to eliminate the gain rise entirely, you can add capacitance across the feedback resistor to bypass its effect. Note, however, that for some values of R_1, the capacitance value required can be very small. Because the unpredictable stray capacitance is therefore relatively significant, you'll probably want to tune the circuit to adjust the total capacitance.

Taken together, these requirements pose a challenge that you can best resolve by using a capacitor tee network **(Fig 4a)**. The tee network can provide tuning capacitance in the subpicofarad range with little effect by stray capacitance. The tee uses a capacitive divider formed by C_2 and C_3 to attenuate the signal applied to C_1 at the circuit input. C_1, which has only a fraction of the output signal, supplies far less shunting current to the input node than it would as a direct-feedback capacitor. Controlling the attenuation ratio is tunable capacitor C_3, the largest of the capacitors (its capacitance value is more readily available in tunable form). Because C_3 is grounded, it has a shielding effect that reduces the influence of the stray capacitance during tuning.

Another way to achieve a practical feedback-resistor bypass is to use a resistor tee to replace the high-value feedback resistor **(Fig 4b)**. In this circuit, resistor elements of a lower value replace the single feedback resistor, but they also introduce greater low-frequency noise. The attenuator operates in much the same way as the capacitor tee does: R_2 and R_3 attenuate the signal to R_1 so that the latter appears to the input node as a much larger resistor. A similar opportunity for the dc-error-compensation resistor R_4 does not exist. Any dc error caused by the amplifier's input current is the same whether you use a resistor tee or a capacitor tee, so you need to use the large-valued compensation resistor in either case.

The resistor tee somewhat reduces the stray capacitance across the feedback path because of the extra physical spacing of the three feedback elements. Also, stray capacitance across each individual element has much less effect because the elements' resistances are low. Other stray capacitances from the op amp's output to its input aren't affected by the resistor tee, however.

You can intentionally bypass R_2 with the appropriate capacitor values. Bypassing the moderate resistance of R_2 removes the feedback attenuation at higher frequencies, leaving the net feedback resistance at the value of R_1. This operation differs from true feedback bypassing in that the impedance levels off rather than continues to fall with frequency, but the dramatic drop in equivalent resistance serves the circuit requirement. Another benefit offered by the resistor tee is more accurate dc-error compensation. The low resistor values of the resistor tee allow you to tune the resistance. Resistance tuning

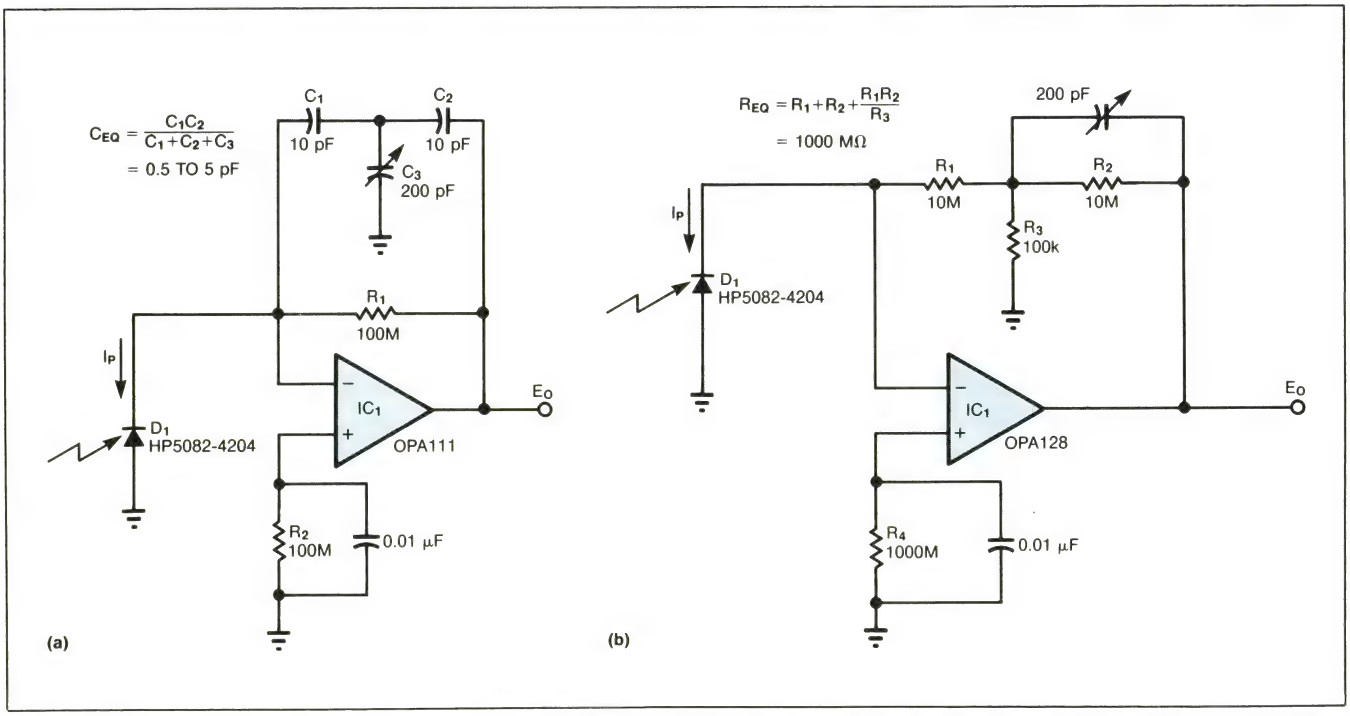

***Fig 4—To remove amplifier gain peaking** by means of a small capacitive bypass of the large feedback resistance, you can use a capacitor tee **(a)**, or you can bypass one element of a feedback resistor tee **(b)**.*

Adding voltage gain to a current-to-voltage converter will increase the circuit's bandwidth faster than it increases noise.

is most useful for very high resistance values, at which wide resistor tolerances degrade the dc-error compensation.

Although the tee-element bypass reduces high-frequency noise, it also increases the noise at lower frequencies. Below the frequency of the bypass, the noise gain increases because of the tee network's feedback attenuation. The net result is the amplification of the noise and offset voltages of the op amp, as well as the noise of resistor R_1, by a factor of $1+(R_2/R_3)$. The resistor's smaller value counters this factor, so the noise increases only by the square root of the new noise gain. Most important, however, is the fact that the bypass capacitor removes high-frequency gain by eliminating the greatest portion of the previous noise bandwidth. In the absence of other means to remove the high frequencies, the bypassed resistor tee provides lower total output noise for the higher ranges of feedback resistance.

Adding feedback capacitance is an effective means of reducing noise gain, but it also decreases signal bandwidth by the same factor. The bandwidth is already low for high values of feedback resistance, and the end result can be a response of 1 kHz or less. A better solution to the noise problem is to limit amplifier bandwidth to a point just above the unavoidable signal-bandwidth limit. This action removes the high-frequency gain that only amplifies the noise. Op amps with a provision for external phase compensation offer this option, but those available lack the low input currents and low voltage noise needed for photodiode monitoring.

Composite amplifiers provide a solution

The solution to this problem is to use a composite amplifier (**Fig 5**) comprising two op amps: One provides for low input currents and low voltage noise; the other provides phase-compensation control. Note that to retain a single phase inversion with two amplifiers in series, you must reverse (in comparison with single op-amp configurations) the inverting and noninverting inputs of IC_1, as **Fig 5** shows. In the composite structure, internal feedback controls the frequency response of the gain added by IC_2. At dc, the feedback is blocked by C_1 and the overall open-loop gain is the product of the two amplifiers (225 dB for the amplifiers shown). This gain is rolled off by the open-loop pole of IC_1 and by the integrator response established for IC_2 by C_1 and R_3. Because this is a 2-pole roll-off, to establish frequency stability the circuit must reduce the roll-off before intercepting the noise-gain curve.

Resistor R_4 reduces this roll-off by introducing a zero response. Above the frequency of that zero response, R_4 also replaces the integrator response with that of an

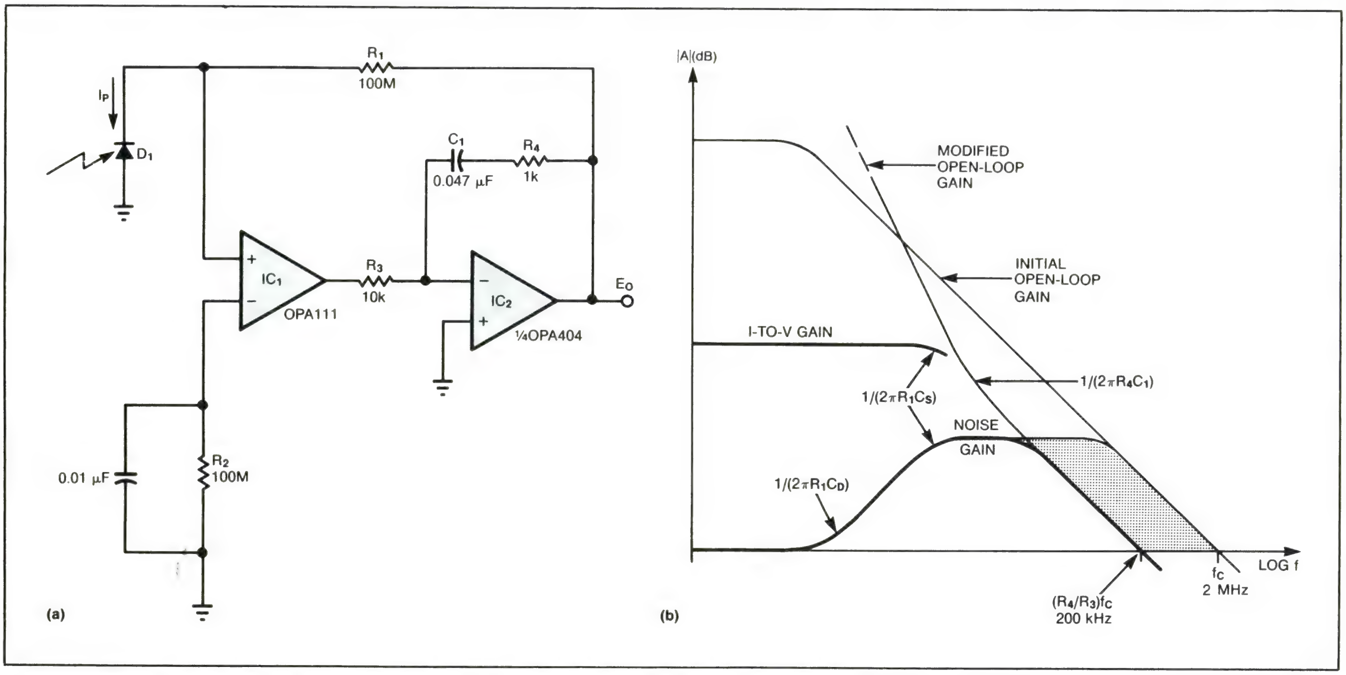

Fig 5—Noise reduction occurs *in a composite amplifier* ***(a)*** *that restricts noise bandwidth* ***(b)*** *without reducing the signal's bandwidth.*

inverting amplifier that has a gain of $-R_4/R_3$. Making this gain less than unity drops the net-gain curve below that of a single amplifier at high frequencies. Graphically, the noise-gain response of **Fig 5b** moves back in frequency as though the op-amp bandwidth had been reduced.

Eliminated is the shaded area of noise gain, which may not appear to be large because of the logarithmic frequency scale, but which actually encompasses a wide frequency range of associated noise reduction. Moving the unity-gain crossover of the noise gain from 2 MHz to 200 kHz, as shown, lowers the output noise of IC_1 by about a factor of three.

The same output-noise drop in a feedback-bypassing configuration, such as **Fig 4b's** circuit, would lower the signal bandwidth by a factor of 10. **Fig 5a's** circuit, however, has no effect on signal bandwidth, and the high gain of IC_1 eliminates any noise or offset effects by IC_2. Because of the exceptionally low noise of the OPA111 input amplifier, this improvement reduces noise to the fundamental limitation imposed by the feedback resistor. This condition is retained for all practical values of feedback resistance. For the second amplifier, the wideband OPA404 continues its attenuating amplifier action well beyond the unity-gain crossover of IC_1. This attenuating action avoids a second gain peak that could cause oscillation. The signal bandwidth of the current-to-voltage conversion is essentially unaffected because there's no influence on R_1.

The technique used in **Fig 5** is most useful with low-level signals that are very sensitive to noise. In higher-level applications, the circuit can encounter a voltage-swing limitation caused by the maximum output-voltage limit of IC_1 and its attenuation by IC_2. If the output of IC_1 has a peak swing of 12V, and IC_2 has a gain of $-\frac{1}{10}$ as shown, the final output is limited to a 1.2V peak swing. For lower-level signals this peak swing is acceptable, because the maximum practical level of feedback resistance already limits the output swing.

Bandwidth and noise are related

The output noise of a current-to-voltage converter increases in proportion to the square root of the system bandwidth simply because of the broader noise spectrum. The optimum S/N ratio occurs at very high gain, but high-gain current-to-voltage converters have bandwidth limitations far below the roll-off of the op amp. To the signal current, the amplifier feedback factor is unity, a condition that would normally make available the full unity-gain bandwidth of the amplifier. However, the high values of feedback resistance used to produce the desired gain are shunted by stray capacitances that greatly reduce the potential bandwidth. Just 0.5 pF of stray capacitance around a 100-MΩ feedback resistor will pull the signal bandwidth's unity-gain crossover from the megahertz range to 3.2 kHz.

To minimize the shunting effect, you should use low-capacitance resistors and take precautions during circuit assembly. For example, by mounting the feedback resistor on standoffs, you can reduce the resistor's capacitive coupling with the printed-circuit board. It's also a good idea to insulate the standoffs with Teflon to reduce leakage currents. To avoid introducing noise from the microphonic effects of mechanical stress or vibration, you should make the mounting as rigid as possible.

There's an ultimate limit to the effectiveness of the measures you take to minimize the shunting effects, because capacitive coupling through the air around the resistor body always remains. Increasing the bandwidth beyond that imposed by such residual limits requires lower feedback resistance and accompanying lower converter gain. One of several options available to restore the gain is shown in **Fig 6a**: You simply add a second amplifier with voltage gain to the current-to-voltage converter in order to retain the net input-to-output transimpedance ($R_T=A_VR_1$). The usual high-value resistance is reduced by a factor equal to the voltage gain of the second amplifier, which increases the bandwidth by as much as the same factor.

Although this scheme is an obvious alternative, the second amplifier's overall effect on bandwidth and noise is not so immediate. The response limitation of the second amplifier bounds the upper end of the bandwidth increase. The bandwidth of the 2-op-amp circuit, which has a net transimpedance of 100 MΩ, is plotted in **Fig 6b** as a function of the voltage gain in the overall conversion. The bandwidth initially increases linearly with voltage gain as the reduction in R_1 diminishes the roll-off effect of stray capacitance. However, the added demands of the voltage gain on IC_2 eventually make that amplifier's bandwidth the controlling factor.

For a given set of conditions, you can find an optimum gain (A_V) that produces the peak bandwidths shown for the three sample amplifiers. The peak occurs when the amplifier's closed-loop bandwidth and the stray-limited bandwidth of R_1 coincide. Variables affecting this peak are the net transimpedance, R_T, and the second op amp's unity-gain bandwidth, f_C. The relationship of the

Because of its very high resistance, a current-to-voltage converter is sensitive to noise coupling from electrostatic, magnetic, and radio-frequency sources.

controlling factors at the optimum bandwidth point is shown in the expression that defines the choice of R_1:

$$R_1=\sqrt{R_T/2\Pi C_S f_C}.$$

Extending the bandwidth

You can extend the bandwidth of **Fig 6a**'s circuit to 100 kHz (from the original 3 kHz) by using the wideband OPA404 for the second amplifier. This wideband op amp offers the best frequency response of the three **(Fig 6b)** and, although its total output noise is greater, that output noise is largely caused by the greater available bandwidth. If you require even greater bandwidth, you can choose either a faster op amp (which typically has poorer noise performance) or a lower transimpedance. With its unity feedback factor, IC_1 encounters lower demands on bandwidth, so **Fig 6a** uses a low-noise OPA111 FET amplifier.

The price you pay for improved bandwidth through voltage gain is increased output noise. Although the lower value of R_1 reduces its noise density, the increase in bandwidth counteracts that effect for a net zero change in resistor noise. The second amplifier amplifies the resistor noise, causing an increase in output noise proportional to the voltage gain. The noise from the op amps themselves adds to the amplified resistor noise; **Fig 6b** shows the net result. The noise curves are continuations of the ones presented in **Fig 3**, except that in **Fig 6b** the transition begins at 100 MΩ.

In the lower gain range, from one to 10, the noise is largely a result of the op amps and their gain peaking, but those effects give way to resistor noise dominance before the end of this range. Stray capacitance controls the signal bandwidth in this range, and the plotted bandwidth shows a linear increase with gain as a result of the corresponding decrease in resistance. When the gain is between 10 and 100, the bandwidth begins to drop because of the limitations imposed by IC_2. Coincident with this drop in gain is a flattening of the output noise curve. Roll-off of the amplifier's bandwidth and the simultaneous resistance drop nullify the effect of any increasing voltage gain, leaving output noise constant. In the voltage-gain range from 100 to 1000, these trends continue; they degrade the circuit's optimum performance because the bandwidth gets narrower while the noise remains constant.

Although the noise degrades with the voltage gain's replacement of resistance, the circuit's overall performance improves. The improvement in bandwidth more than offsets the drop in signal-to-noise ratio.

As already mentioned, the simple current-to-voltage converter exhibits a problem: It has a greater bandwidth for the amplifier voltage noise than it does for the signal current. The circuit in **Fig 6a** removes this discrepancy; as the voltage gain increases, IC_2 begins to filter out the higher frequencies. You can find evidence of this filtering in the noise curves of **Fig 6b**, which increase more gradually than do the bandwidth curves, until they reach the optimum bandwidth point. At this optimum point, noise bandwidth and signal bandwidth are equal. In effect, IC_2 also serves as the output active filter discussed earlier. Each of the curves in **Fig 6b** is

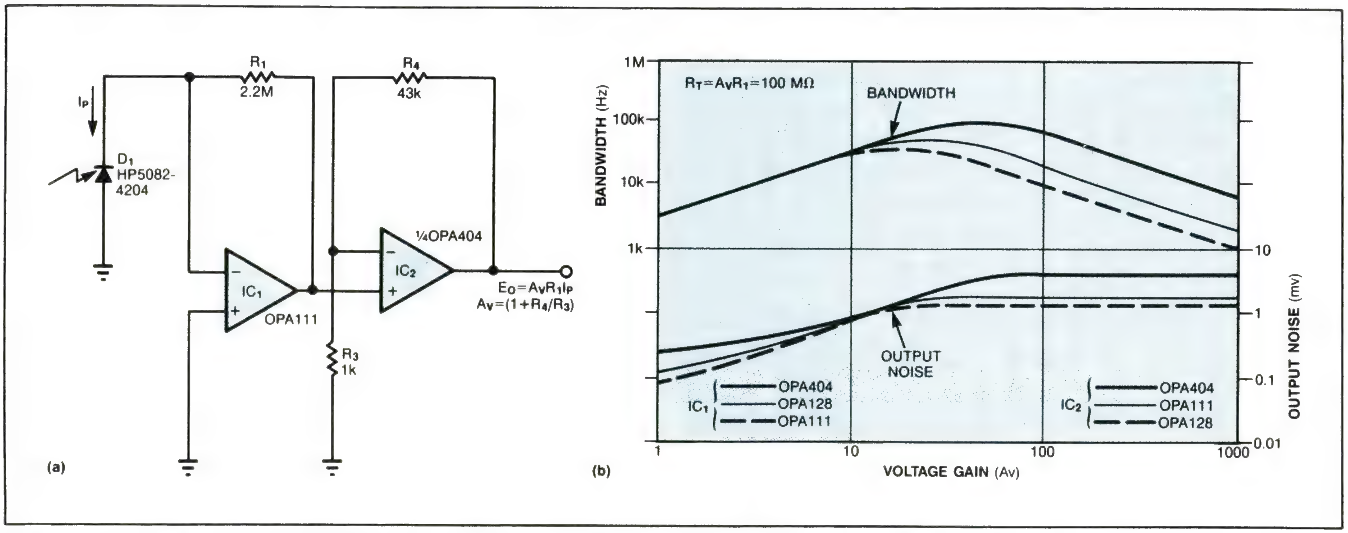

Fig 6—For greater bandwidth and the same net transimpedance *as those of the circuit in* ***Fig 5a,*** *this circuit* ***(a)*** *adds voltage gain; its bandwidth* ***(b)*** *increases faster than the noise does.*

drawn for a 100-MΩ transimpedance and for the amplifiers and photodiode specified.

For some of the more common photodiode applications, a significant drawback of the **Fig 6** circuit is that it requires two op amps per photodetector. This requirement can pose a real problem in large photodetector arrays, which often employ hundreds of detectors. You can compromise, as long as you're willing to accept some noise and bandwidth degradation, by using one op amp to provide the same transimpedance, and you don't need the very large resistors. A single op amp can perform the current-to-voltage conversion and can also provide the subsequent voltage gain.

The traditional way to accomplish this task would be to design a circuit like **Fig 7a**'s, which uses R_2 for the conversion and R_3/R_4 to set the voltage gain. Current from D_1 flows in R_2, resulting in a signal voltage at the input of the noninverting amplifier. However, that signal voltage is also across the photodiode, and this condition produces a nonlinear response.

Alternatively, you can use the configuration in **Fig 7b**, in which the diode is connected directly between the op-amp inputs, maintaining a zero diode voltage. Current from the photodiode still flows in R_2 and develops the same signal voltage. Diode current also flows into the feedback network, but has little effect because of the low resistance values. For the resistor values shown, the circuit exhibits a transimpedance of 100 MΩ, just as the 2-op-amp example does, but its bandwidth has improved less.

At 20 kHz, the bandwidth increases by a factor of seven rather than by a factor equal to the voltage gain, as in **Fig 6a**. A new bandwidth limitation accounts for the difference; it occurs because of the new placement of the high-value resistance. That resistor is now shunted by the op amp's common-mode input capacitance instead of just by the smaller stray capacitance. To maximize bandwidth, you make this new shunting effect coincide with the amplifier roll-off by your choice of R_2 and the amplifier voltage gain. A second benefit of this choice is that the resistor noise beyond the signal bandwidth experiences a 2-pole roll-off.

As expected, the final output noise from the resistor increases over that of the basic circuit by the square root of the voltage gain. A small noise component that's normally caused by the op amp's gain peaking is no longer present. However, **Fig 7b** includes a new noise source caused by the diode capacitance (which is modeled in **Fig 8a**). The amplifier voltage noise, E_N, is impressed directly across the diode capacitance, developing a noise current that flows in R_2. This noise current creates a noise voltage that is a multiple of E_N at the input of the noninverting amplifier. The capacitive feedback network of C_D and C_{ICM} produces a noise gain that peaks at $1+(C_D/C_{ICM})$; this noise gain exists in addition to the normal voltage gain of the noninverting amplifier.

The effects of the new noise source on the frequency response are plotted in **Fig 8b**; again, they produce a high-frequency peak in the noise gain. This peak occurs at a much higher frequency than does the peak of the basic current-to-voltage converter (because the conversion resistance in **Fig 8a**'s circuit is lower), and it's truncated earlier by the op amp's roll-off. For the low-capacitance diode used in both circuit examples, the new peaking encompasses only a small area in the

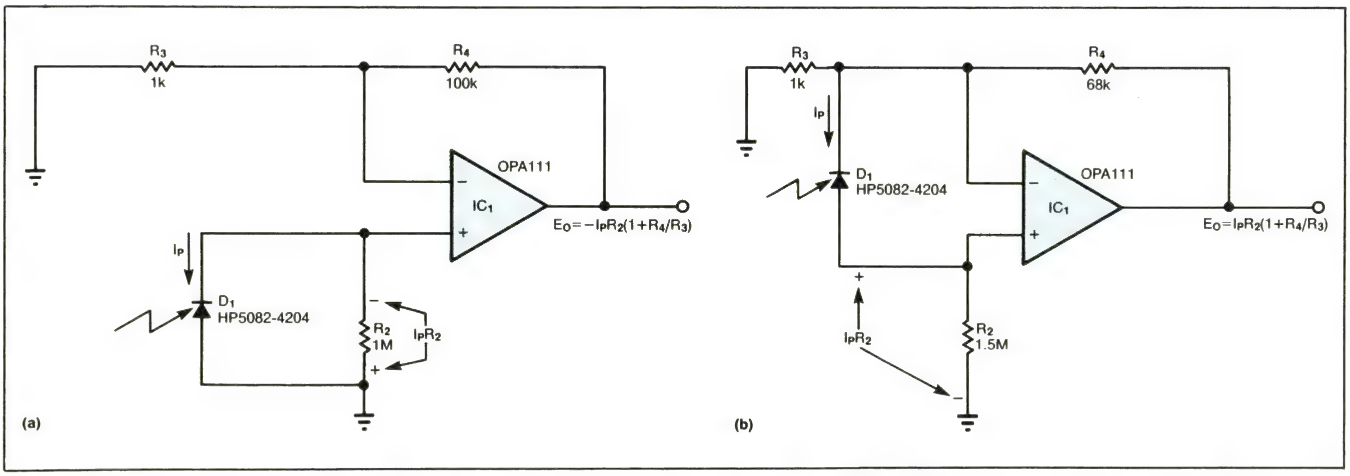

Fig 7—Combining current-to-voltage conversion and voltage gain *and using one op amp, the circuit in* ***a*** *impresses unwanted voltage on the diode. To remove the unwanted voltage, you can connect the diode between the op-amp inputs* ***(b)****.*

Magnetic coupling of noise is harder to eliminate than the electrostatic type is, but an op amp's differential input helps to reduce its effect.

response plot, corresponding to less noise effect. Larger diodes don't escape the effect, as **Fig 8b** shows; the dashed line corresponds to the noise gain for a capacitance of about 200 pF. Even here, the spectrum covered by the peaking is not the high end of the op amp's bandwidth as it was in the basic circuit. Hence, op-amp noise is not the overriding source of noise.

External noise can cause interference

Once the diminishing returns limit the reduction of noise caused by the circuit itself, you must consider external noise sources. With its very high resistance, a current-to-voltage converter is extremely sensitive to noise coupling from electrostatic, magnetic, and radio-frequency sources. Unless you pay careful attention to shielding, grounding, and the physical location of components, those sources could become the dominant noise contributors (**Ref 3**). In each case, the most important step to take is to physically separate the noise source from the sensitive circuitry.

You must take other measures as well, however. Electrostatic coupling, such as from the power line, supplies noise signals through the mutual capacitances that exist between any two objects. Voltage differences between the objects are impressed on those capacitances, and any voltage variation couples a noise current from one to the other. To avoid that error signal, you should use electrostatic shielding to intercept the coupled current and shunt it to ground. In this case, the ground must be earth ground, because earth ground is the common reference for the separate objects.

Note, however, that such shields create parasitic capacitances between the components shielded; you must return the shields to the signal common to avoid such coupling. In this way, you make sure that any shield-carried capacitive currents from the output of a current-to-voltage converter are shunted to ground, so they do not present a bandwidth restriction to the feedback resistor. Even so, the shield produces a capacitance from the converter input to ground, possibly adding to the gain peaking and to its effect on the total output noise.

Because electrostatic noise is most often of power-line frequency and is common to all points, the CMR of an op amp tends to eliminate it. At the line frequency, op-amp CMR is very high. However, current-to-voltage converters don't take advantage of an op amp's CMR capabilities, because these circuits have a single-ended rather than a differential input configuration. But you can alter this configuration to obtain improved noise rejection and less dc error. An op amp's CMR is not a total replacement for shielding, because electrostatic coupling doesn't generate perfect common-mode signals at the amplifier's inputs. As a second defense, CMR capability is most useful in removing the residual coupling that passes through shield imperfections.

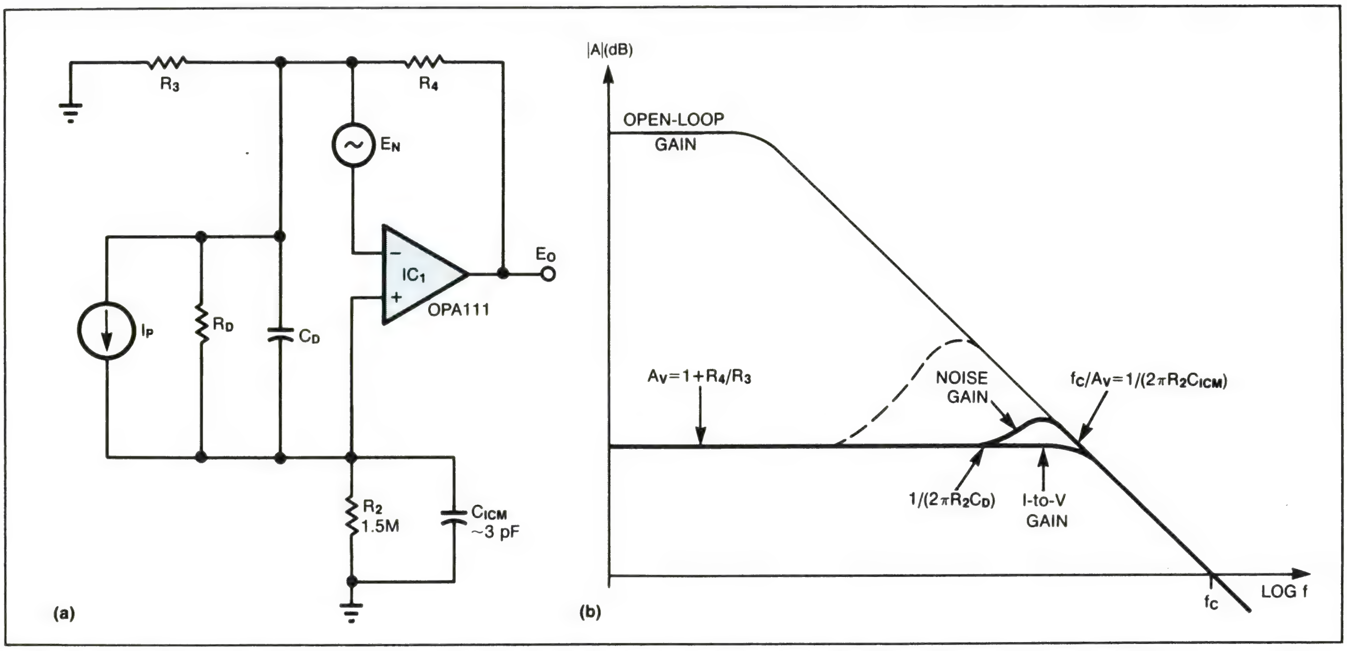

***Fig 8—Photodiode capacitance (a)** adds a positive feedback path that provides a new but lesser source of gain peaking **(b)**.*

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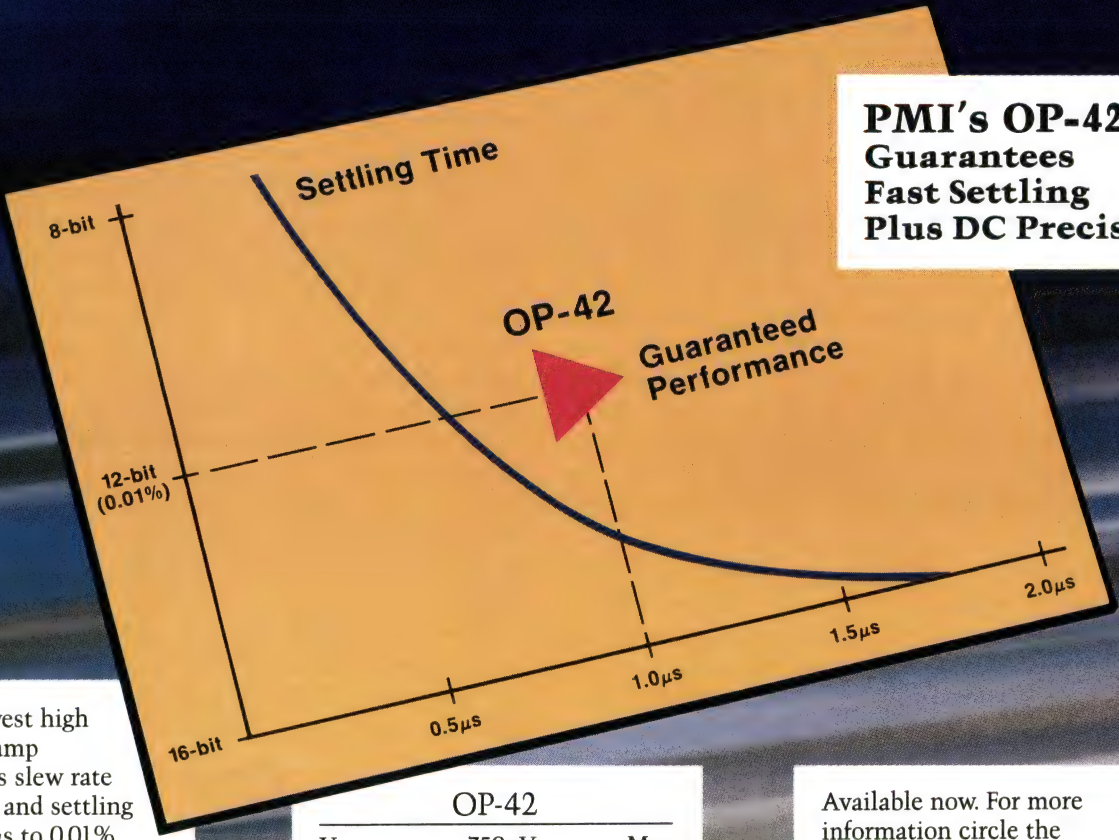

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The differential input capability of an op amp fits exactly with the signal from a photodiode. Because the diode signal is a current, it is available at both terminals of that sensor, and it can drive both amplifier inputs as shown in **Fig 9a**. In that circuit, the diode current is no longer returned directly to common, but drives the amplifier's noninverting input in that path. This setup creates a second signal voltage that doubles the circuit gain when $R_2=R_1$. For a given gain, the resistor value is typically only half the normal value required for a similar reduction in error sensitivity to amplifier input currents. Because the diode is connected directly across the inputs of the op amp, there is essentially no dc voltage across the diode, and the diode leakage current is minimized.

This setup also improves the common-mode rejection of coupled noise. **Fig 9b** models the electrostatic coupling and the parasitic capacitances of this current-to-voltage converter. Because the signal you'd normally get from the photodiode is zero in this example, you can observe only the electrostatic-coupling effects. The electrostatic noise source (E_E) couples error currents (I_E) through mutual capacitances (C_M) to the circuit's two inputs. It might seem that the coupling effects to the two points would be different, because feedback gives the R_1 input node a virtual zero impedance, and the other node is a high impedance. Actually, the noise coupling occurs when voltage signals applied to the mutual capacitances generate currents through those capacitances. Because of the amplifier feedback, both input nodes have the same voltage, and both receive the same level of noise current (I_E). These equal currents develop canceling noise-voltage effects (E_{NE}) on the two circuit resistors, resulting in a zero output signal.

Matching conditions involving the mutual capacitances, the resistors, and the parasitic capacitances shunting them determine the accuracy of the error cancellation. You can best ensure the matching of mutual capacitances by placing the resistors in a position equidistant from any significant noise source that's not effectively blocked by a shield. The equal resistance values will ensure the accurate cancellation of error signals until the circuit reaches operating frequencies at which capacitive shunting imbalances the net impedances. Only about 0.5 pF of stray capacitance shunts R_1, but the much larger common-mode input capacitance of the op amp is across R_2. For the 3 pF of the OPA111 and the 50-MΩ resistance shown, a pole occurs at about 1 kHz, leaving the impedances of interest unbalanced. This shunting by C_{ICM} also imposes a signal-bandwidth limitation at a lower frequency than usual. The bandwidth of R_2 rolls off earlier than does R_1's, creating a response with two gain plateaus separated by a factor of two.

This capacitive shunting has little effect, however, on the most common electrostatic coupling at the power-line frequency. To better reject higher frequencies, you can add capacitance around R_1 to restore impedance

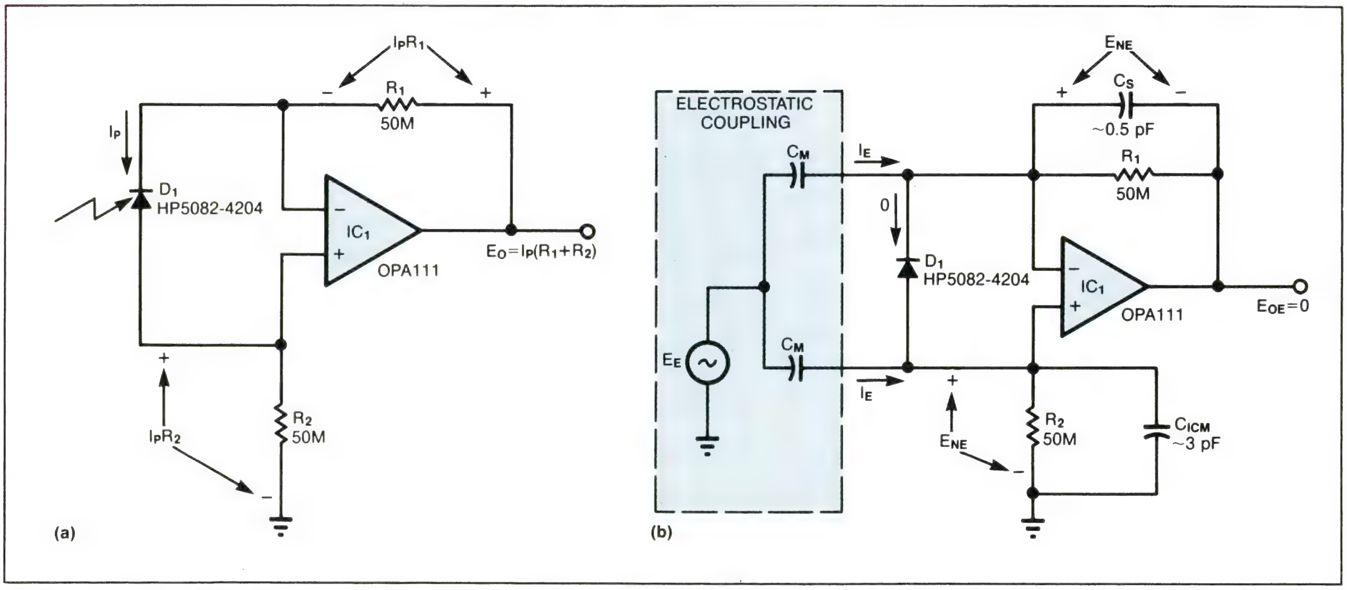

***Fig 9—Exploiting the CMR capabilities** of the op amp, the photodiode **(a)** drives the differential inputs, thus providing rejection of electrostatic coupling **(b)**.*

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You can best match mutual capacitances by placing the resistors equidistant from any unshielded noise source.

matching, or you can avoid signal swing on the common-mode input capacitance. The latter option offers a more accurate solution and avoids the bandwidth limitation of C_{ICM} by using a second differential connection.

Photodiode connection determines performance

Fig 10 shows a photodiode connected between the inputs of two current-to-voltage converters whose outputs drive an INA105 difference amplifier. Again, the diode current flows in two equal resistances that will receive equal electrostatic noise coupling. The diode current creates a differential output on the resistances, but the noise coupling generates a common-mode signal. These two signals are separated when they're supplied to the INA105: The diode signal is passed to the output, and the noise is rejected.

This new differential-input circuit retains the lower-value individual resistances and a zero diode voltage. The zero diode voltage is a result of the grounded noninverting inputs of both current-to-voltage converters. These connections also avoid signal swing on the common-mode input capacitances, improving bandwidth in electrostatic suppression and signal gain. Note that the noninverting inputs are not connected through high resistances for input-current error correction. Such a connection is not necessary because the input currents of IC_1 and IC_2 produce matching voltages at the amplifiers' outputs. These voltages are a common-mode signal to the input of the INA105, so they, too, are rejected.

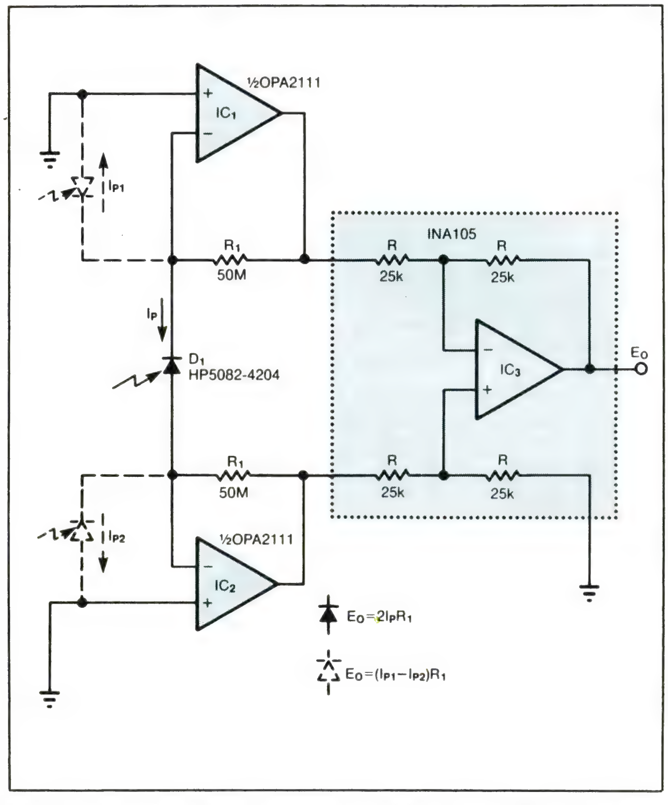

Fig 10—By using two current-to-voltage converters, *you can obtain differential inputs with wideband-CMR and -gain characteristics, because the common-mode input capacitances of IC_1 and IC_2 are virtually connected to ground.*

The differential structure of **Fig 10** also provides for the difference monitoring of two photodiodes. Instead of D_1, you connect two diodes (in the dashed lines) separately to the inputs of the current-to-voltage converters. The diodes' currents produce independent voltages at the outputs of IC_1 and IC_2. The difference amplifier processes these voltages to remove any common-mode portion. What remains is an output that's proportional to the difference between the two input photocurrents; this output is a measure of relative light intensity. (A relative-light-intensity measure is the type of signal used in position sensing or optical-tracking control to direct the feedback correction.)

Magnetic coupling of noise can be more difficult to eliminate than electrostatic coupling, but **Fig 10**'s differential input connections reduce magnetic-coupling effects as well. In this circuit, magnetic coupling occurs through mutual inductances; to control it you must keep the sensitive loop area at a minimum, provide shielding, and separate the source and receiver as far as possible.

The electrostatic shield doesn't remove the effects of magnetic coupling, however, so the first step is to control the source itself **(Ref 3)**. You can internally shield any power transformers that can't be placed at a distance, thus essentially terminating their magnetic fields at the transformer boundaries. To deal with any remaining magnetic coupling, you must adjust physical and circuit configurations. For example, high-value resistors used in photodiode monitoring are sensitive to magnetic coupling, so you must keep connections short between these resistors and the high-impedance op-amp inputs.

To allow the op amp to provide maximum noise rejection, you should make any remaining coupling effects appear as common-mode signals by adjusting the loop size and performing distance matching. In the circuits in **Figs 9** and **10**, the high resistance is divided into two equal elements that are each physically mounted with the same orientation and spacing relative to the magnetic coupling sources. Noise coupled to the two resistors then causes equal signals that have canceling effects at the circuit output.

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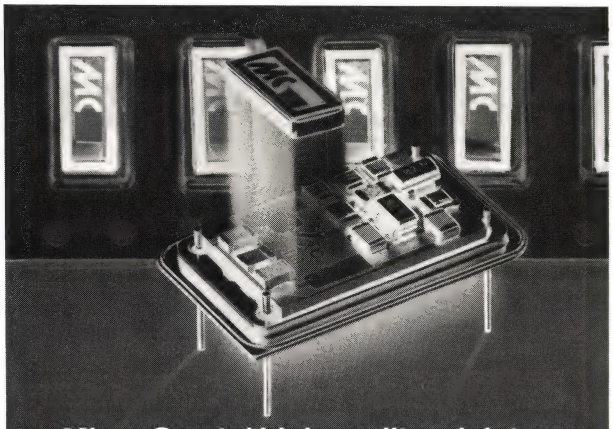

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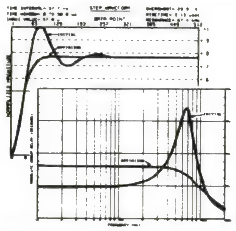

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noise coupling—radio frequency interference (RFI)—so shielding and filtering are the best defenses. Sources of RFI (such as digital circuitry) may be close to the photodiode monitor. Because of the high frequencies involved, op amps have little gain or CMR capability remaining to reject such signals. Because of this same amplifier limitation and the basic bandwidth restriction of the voltage-to-current converter, the desired signals will not be in the radio-frequency range, so you can use filters in front of the op amp to largely remove the unwanted signal. Filtering that follows the op amp is less effective, because the op amp can act like an RF detector, separating a lower-frequency envelope from a carrier (**Ref 4**). You can further reduce RFI by using an RF shield and a ground-plane layer in your pc board. **EDN**

References

1. Tobey, G; J Graeme; and L Huelsman, *Operational Amplifiers: Design and Applications*, McGraw-Hill, 1971.
2. Burr-Brown Corp, OPA101 Product Data Sheet, *PDS434A*, 1980.
3. Morrison, R, *Grounding and Shielding Techniques in Instrumentation*, 2nd ed, John Wiley & Sons, 1977.
4. Sutu, Y and J Whalen, *Statistics for Demodulation RFI in Operational Amplifiers*, IEEE International Symposium on Electromagnetic Compatibility, August 23, 1983.

Author's biography

Jerald G Graeme is manager of Instrumentation Components Design for Burr-Brown Corp (Tucson, AZ), where he directs a linear-IC development group. He holds a BSEE from the University of Arizona and an MSEE from Stanford University. He has been with Burr-Brown for 21 years. In his spare time, Jerry enjoys scuba diving, photography, and woodworking.

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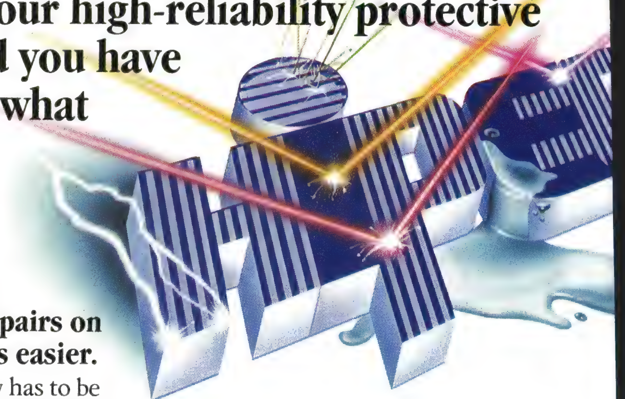

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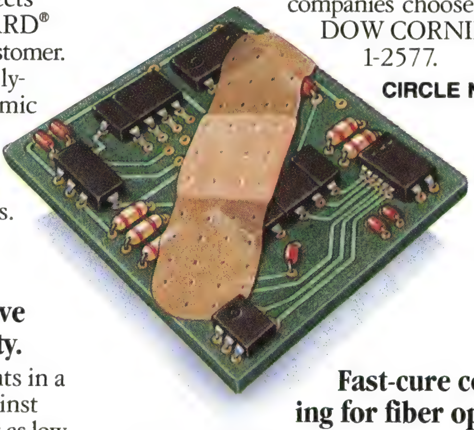

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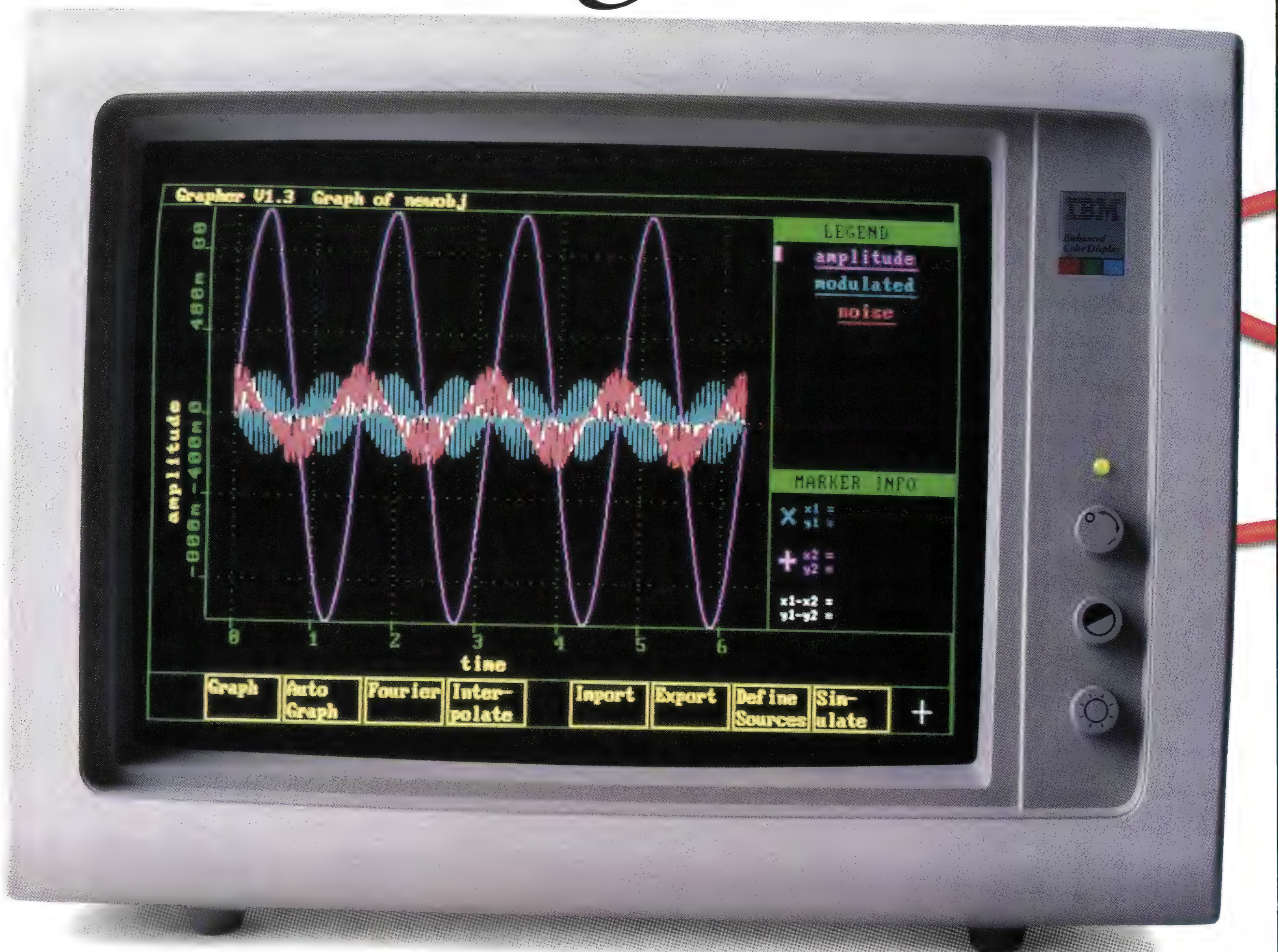

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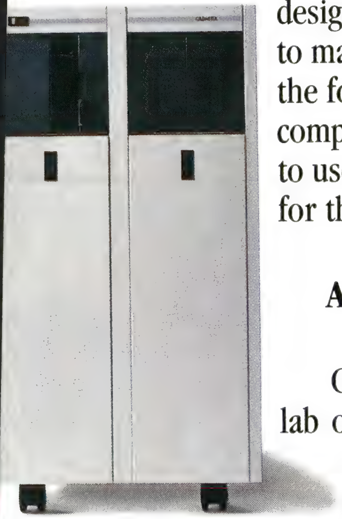

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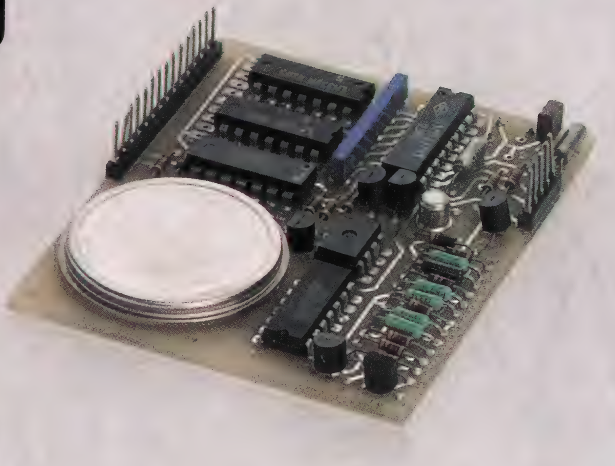

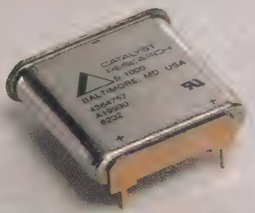

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CIRCLE NO 162

Good design methods quiet high-speed CMOS noise problems

No doubt about it: Today's high-speed CMOS logic can generate a significant amount of noise. This problem is not insurmountable, however. Circuit design techniques that are prudent but not unusual will readily tame troublesome noise.

Tim Tripp and Bill Hall,
Fairchild Semiconductor Corp

Today's high-speed CMOS logic is creating a big controversy over the issue of ground-bounce noise and the problems it creates in digital system design. Using some constructive design techniques can minimize the effects of ground-bounce noise. Minimize is a key word here, because designers do not have total control over the problem—chip manufacturers have to provide some help, too.

Edge rates of today's advanced high-speed CMOS logic families are much faster than those for HC/HCT CMOS logic and the popular low-power Schottky TTL (LSTTL) and advanced low-power Schottky TTL (ALSTTL) bipolar logic. These faster edge rates generate noise effects that are more pronounced than in older, slower logic technologies. Hurried solutions, such as increasing package size and changing traditional power and ground pinouts, will do little to ease the task of designing advanced CMOS into high-performance systems. What you need are intelligent technology tradeoffs that balance the need for device speed against system noise constraints.

Although CMOS was originally introduced to satisfy low-speed, low-power applications, today's devices have the switching speed and drive capability necessary to accommodate high-performance system needs. Not surprisingly, higher noise levels go hand in hand with gains in performance. With its rail-to-rail voltage swings (which equate to greater dV/dt), advanced CMOS generates more noise than does LSTTL, which has both slower edge rates and smaller voltage swings.

Some noise effects are inconsequential because they fall within the switching time of the devices. But you must neutralize others by using careful design and layout techniques. Your effort will be worthwhile, however. Advanced CMOS operates at clock rates exceeding 100 MHz and consumes about the same static power as first-generation CMOS devices. And with its higher output capability, today's high-speed CMOS families, such as Fairchild's Fact devices, can directly drive transmission lines.

Logic designers and chip manufacturers share responsibility for minimizing CMOS device noise and the system noise it spawns. Logic designers can reduce capacitive loading on signal lines and provide optimum power and ground planes. For their part, chip manufacturers must strike a balance between how fast a logic

Faster edge rates in high-speed CMOS generate noise effects that are more pronounced than noise in older, slower logic technologies.

device switches and how much noise it generates. The faster the slew rate, the greater the noise generated at the device output. By slightly reducing edge rates, a chip maker need not change the device packaging or pinouts to reduce noise levels.

Minimizing ground bounce benefits other noise effects that limit system performance. These effects include overshoot, undershoot, and propagation-delay degradation. The problems with ground-bounce effect all begin at the output stage of a gate.

Modeling the bounce

The schematic in **Fig 1** shows the output stage of a CMOS gate driving a capacitive load. The gate's package connections and leads have a certain amount of inherent inductance. When the gate switches from a high to a low state, current stored in the load capacitance flows to ground through the lower N-channel output transistor and the package inductance.

As the formulas in **Fig 1** show, the load capacitor's discharge current I is a function of the load value and the output transition. As this current flows through the package inductance L_P, it creates a voltage V_{GB}, better known as ground bounce.

The equations in **Fig 1** seem to simplify the ground-bounce phenomenon, but secondary and tertiary effects make it difficult for chip manufacturers to develop a practical ground-bounce model. At first glance, it seems that reducing L_P will decrease V_{GB} proportionally. Unfortunately, reducing L_P increases the rate of current flow and thereby minimizes the decrease in V_{GB}.

Some manufacturers have designed appropriate output configurations that reduce the initial transient current that flows into the intrinsic package inductance. There's a limit, however, to how much they can slow the initial transient current without compromising gate speed. It is possible, though, to strike a balance that provides a controlled output that's sufficiently fast to provide high performance and still slow enough to reduce bounce voltage.

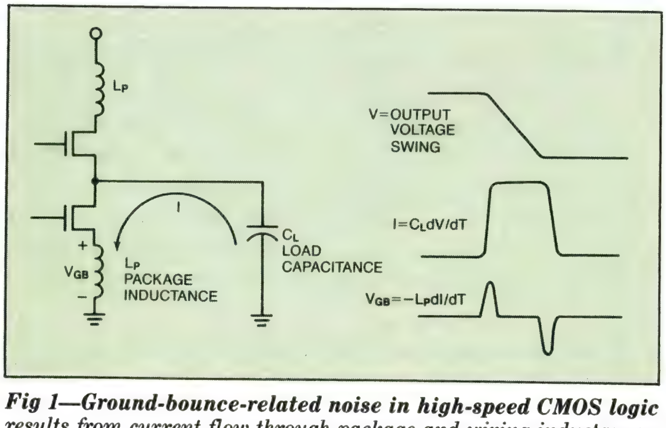

Fig 1—Ground-bounce-related noise in high-speed CMOS logic *results from current flow through package and wiring inductances. The devices fast edge rates, rail-to-rail voltage swings, and high output-current capability combine to maximize the ground-bounce problem.*

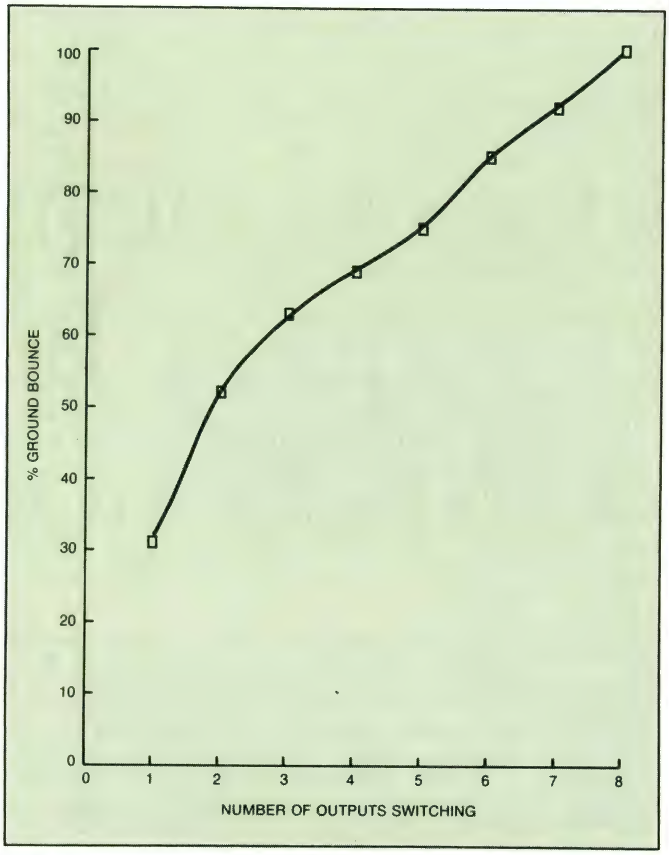

Fig 2—Ground-bounce noise is a cumulative problem. *The greater the number of outputs you activate, the greater the relative ground-bounce noise.*

The key point to note is that the chip manufacturer is responsible for reducing system noise effects—particularly ground bounce that stems from fast voltage transitions on switching signals. This responsibility does not eliminate the system designer's responsibility, however. Proper design and layout techniques will further reduce ground bounce.

Fig 1 models ground bounce for a single-output device. Devices with multiple outputs have nodes where the output transistors physically connect to the common package inductance. With multiple-output switching, there is a cumulative current flow through the common package inductance, which proportionally increases ground bounce.

The curve in **Fig 2** shows the relative increase in ground-bounce noise as a function of the number of outputs being switched. Curve development assumes that a single switched output generates 30% of the maximum ground-bounce voltage. As the curve shows, three switched outputs generate 60% of the maximum voltage—twice as much noise as a single output. And seven outputs generate 90% of the voltage—three times as much noise as a single output.

Propagation delay is one parameter that suffers from excessive ground-bounce created when switching multiple outputs. As **Fig 1** illustrates, the greater the voltage drop across the package inductance (V_{GB}), the lower the voltage drop across the gate's output transistor. The lower voltage level reduces the rate of current discharge from the load capacitors, which slows down edge rate and degrades propagation delay. The effect is most pronounced, for example, when all the outputs of an octal bus-driver IC switch simultaneously.

The scope waveforms in **Fig 3** illustrate the degradation of delay parameters under multiple-switching conditions. The curves on the left represent the clock input of an octal D-type flip-flop; the curves on the right illustrate the performance for varying numbers of switched outputs. The propagation delay from the input to the first output is about 6.5 nsec. As each additional output line activates, however, the input-to-output delay begins to increase. The delay difference for one and two switched outputs, for example, is about 200 psec, and for three outputs, it's about 400 psec. In essence, delay increases about 200 psec for each additional output.

As shown, the additional delay is greater than 1 nsec with seven outputs activated. Obviously, such a timing delay or system skew can affect projected operation. Fortunately, some manufacturers specify typical guidelines for propagation delay degradation due to multiple-output switching.

Ground-line bounce is more of a problem

As **Fig 1** illustrates, bounce is present on both the ground and V_{CC} lines of the device. Typically, spikes on the ground line cause more problems because TTL has less noise margin in the low-voltage state (logic 0) than in the high-voltage (logic 1) state. However, either ground or V_{CC} bounce can couple onto an active signal and develop undershoot or overshoot. An undershoot can drive a nominal 0V below ground, and an overshoot can drive a high-level signal above V_{CC}. Although some specialty devices (such as dynamic RAMs) are sensitive to undershoot, most general-purpose logic provides input protection, such as clamp diodes, to guard against these anomalies.

Quiet output switching (QOS) is the ground-bounce offshoot that primarily concerns most system designers. QOS is ground bounce that couples onto a non-switching output through the package inductance. Typically, QOS levels are benchmarked using industry-standard test fixtures, which consistently provide good correlation when measuring multiple devices under varying test conditions. Test-fixture measurements at the worst-case output pin of an advanced CMOS octal device under worst-case conditions show that typical bounce-voltage values range from 1.8 to 2.4V. However, test-fixture results do not represent real-life system QOS levels.

Test fixtures have lumped-load 50-pF chip capacitors soldered directly to the output pin of the DUT (device

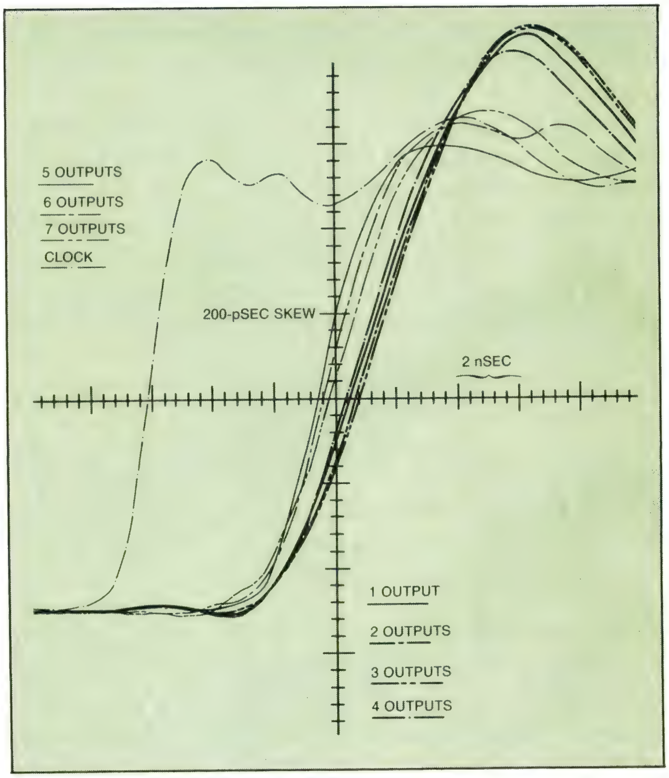

Fig 3—Propagation delays become skewed *in a high-speed octal driver as the number of activated outputs increases. A delay difference as high as 1 nsec can occur between switched output extremes, that is, one output switching and seven outputs switching. Such a delay difference can readily cause malfunctions in the system logic devices.*

Chip manufacturers are responsible for reducing system noise effects.

under test), while a real-life system has distributed loads along a transmission line. The additional transmission-line impedance reduces the initial transient current and thereby lowers the QOS levels. In addition, test-fixture outputs act like an LCR tank circuit and create an oscillation effect on the ground-bounce waveform. Using advanced CMOS octals in a typical system under worst-case conditions, QOS can range from 0.3 to 1.2V—well below what you'll observe in test fixtures.

Ground-bounce-related effects introduce spurious noise on signal lines that can erroneously trigger logic devices, so you must design to minimize such occurrences. To start, you must identify when a system is most likely to respond to noise effects. Generally, it occurs when a portion of the system operates asynchronously.

Under synchronous control, ground bounce occurs only when triggered by the clock, which makes the noise more predictable and easier to control. Moreover, noise spikes appear when they can do no damage (**Fig 4**). The small pulse shown at the bottom is the quiet output noise, and the signal that is changing states from high to low is that of an active output on the same device.

Note that the bounce signal reaches an amplitude of about 1.2V but quickly dissipates back to ground level. The point is that the noise occurs as a result of the switching output, which changed state under clock control. As shown, the noise dissipates within the device's propagation delay so it will not be detected by any other device that is under control of the same system clock.

Designers go to asynchronous operation to maximize system speed. Because the logic runs in a random fashion in such systems, ground-bounce-induced noise can invade a logic device and cause false triggering at almost any time. Crosstalk problems, for example, can be very serious if noise pulses are induced into an asynchronous system control line.

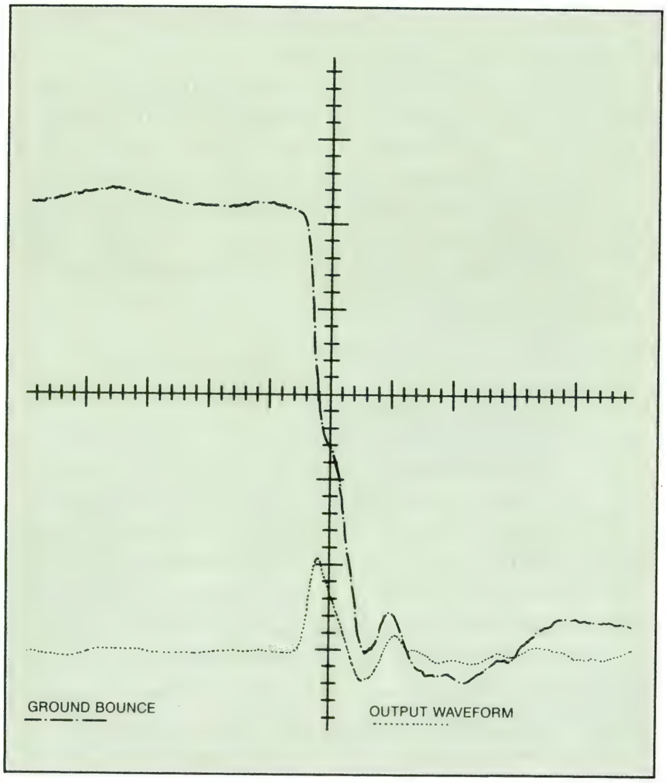

***Fig 4—You can control the effects of ground bounce** by operating logic synchronously rather than asynchronously. If a ground-bounce-induced pulse occurs within the propagation delay of the switching device, it will not cause a system malfunction because switching activity will not take place until a few nanoseconds after the passage of the clock.*

Other problem areas

Operating mode is not the only factor to consider when it comes to ground bounce. The system's susceptibility to ground bounce is also dependent on the thresholds of the logic (TTL or CMOS) used. CMOS thresholds provide better noise margins than do TTL thresholds; therefore, CMOS is less susceptible to false triggering from voltage-bounce effects. In addition, both CMOS and TTL inputs have a form of inherent noise rejection that's based on the amount of energy required to trigger the input (amplitude×duration). The input will either reject a relatively narrow noise pulse (ground bounce, crosstalk, etc) or respond to noise-pulse amplitudes that exceed the specified static-input thresholds.

Ground-bounce problems might seem formidable, but you can overcome them by following some simple guidelines for systems that contain both CMOS and TTL—the case in many systems today. First, try to avoid using TTL devices in any asynchronous portions of a mixed system. Second, if you use any high-speed CMOS octal bus drivers, be aware that ground-bounce noise increases significantly when all outputs switch simultaneously. Third, try to avoid using high-speed CMOS octal devices to drive asynchronous signals into TTL devices. If you must do so, however, you can follow some techniques that will minimize ground bounce.

When driving an asynchronous data line with an octal bus driver, use the output pin that is closest to the package ground pin. Compared to the pin closest to the V_{CC} pin, this technique will reduce noise by as much as

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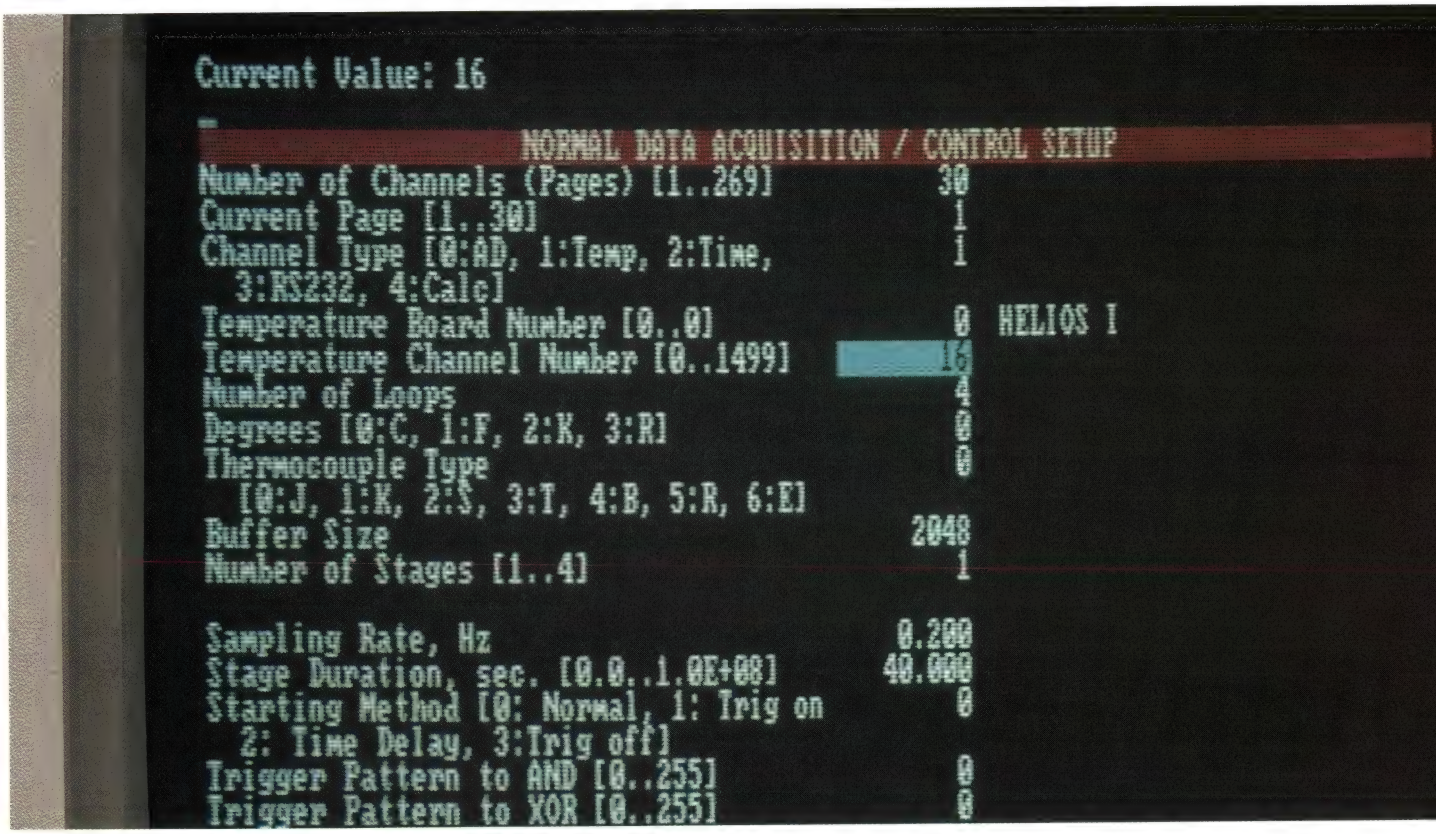

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Current Value: 16
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                   NORMAL DATA ACQUISITION / CONTROL SETUP
Number of Channels (Pages) [1..269]              30
Current Page [1..30]                              1
Channel Type [0:AD, 1:Temp, 2:Time,               1
  3:RS232, 4:Calc]
Temperature Board Number [0..0]                   0  HELIOS I
Temperature Channel Number [0..1499]             16
Number of Loops                                   4
Degrees [0:C, 1:F, 2:K, 3:R]                      0
Thermocouple Type                                 0
  [0:J, 1:K, 2:S, 3:T, 4:B, 5:R, 6:E]
Buffer Size                                    2048
Number of Stages [1..4]                           1

Sampling Rate, Hz                             0.200
Stage Duration, sec. [0.0..1.0E+08]          40.000
Starting Method [0: Normal, 1: Trig on            0
  2: Time Delay, 3:Trig off]
Trigger Pattern to AND [0..255]                   0
Trigger Pattern to XOR [0..255]                   0
```

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CIRCLE NO 158

Spikes on the ground line cause major problems because TTL has less of a noise margin in the low-voltage state.

50%. Driver output pins between ground and V_{CC} will generate increasing amounts of noise voltage. Therefore, always drive TTL devices with the lowest noise driver and use the noisier outputs to drive CMOS logic.

You can also reduce ground-bounce-noise problems by lowering the system's supply-voltage level. You might find this task difficult to perform, but the results are meaningful **(Fig 5)**. This curve illustrates the relationship between supply voltage and relative ground-bounce noise for an octal buffer with seven of its outputs activated. The curve's slope shows that each 1V reduction in V_{CC} reduces ground bounce 18%. Advanced CMOS input thresholds are a linear function of V_{CC} (30% V_{CC}) so each 1V reduction in V_{CC} reduces the threshold by 14%. Given the 18 and 14% figures, it's obvious that reducing V_{CC} improves the noise margin.

Looking at the crosstalk problem

Most of the burden for quieting ground bounce falls on the device manufacturer; however, device manufacturers and circuit designers both have roles to play when it comes to reducing crosstalk problems. Crosstalk noise occurs when signals from one line capacitively couple into an adjacent line. Crosstalk is a function of both the slew rate of the signal and the capacitive coupling between the lines. Device manufacturers bear most of the responsibility for the slew rate, but designers can control the coupling by spacing signal lines properly.

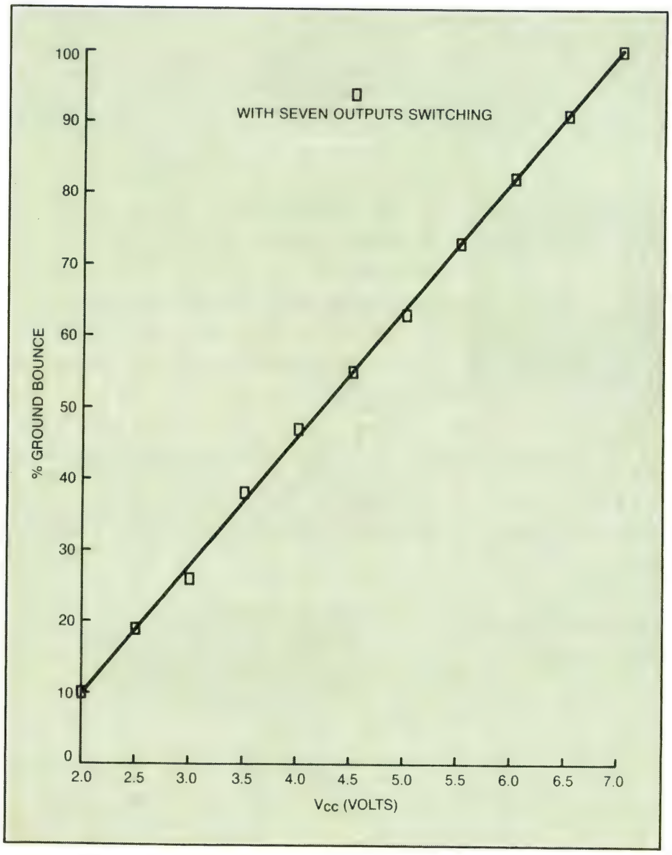

Fig 5—Ground-bounce noise varies directly with the power-supply voltages *used in the system. If you reduce supply voltage by just 1V, you'll reduce ground bounce by about 15 to 20%.*

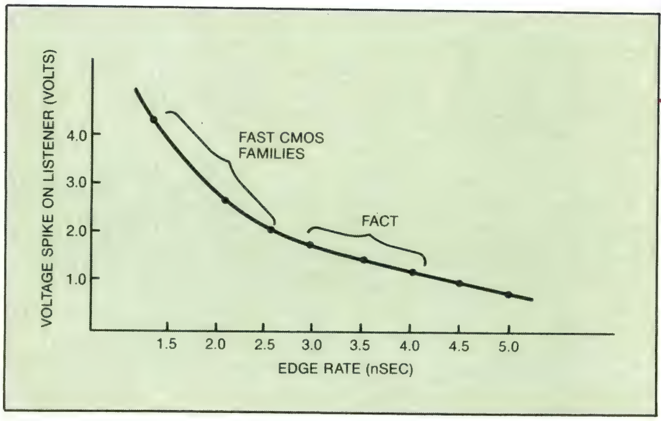

Fig 6—Fast edge rates increase the potential for crosstalk *in a high-speed CMOS system. However, chip manufacturers can lessen potential crosstalk problems by slightly decreasing edge rates, as shown by the figures for the Fact devices.*

Fig 6 illustrates the effect of a signal's edge rate on the noise generated at the input of a receiving device on a parallel line (noted as a listener on the vertical axis of the curve). First, note that edge rate directly influences voltage spike generation—the slower the edge rate, the lower the noise spike amplitude.

Fig 6 was generated from measurements on two 30-in. adjacent pc-board traces terminated with 50Ω impedances. The value of the voltage spike at various edge rates is a function of trace lengths, trace spacing, and termination impedances. Different trace lengths, spacings, and impedances will vary the spike amplitude, but the induced noise spike will always be a function of the signal's edge rate.

Crosstalk, like ground bounce, can be cumulative. If you run wires in a bundle instead of singly, you'll increase the probability of crosstalk problems. To minimize crosstalk, increase the spacing between sensitive lines, or use ground shielding.

Proper board layout is critical

You can take other prudent measures to minimize the effects of edge-related noise. In general, board layout is a key factor. In high-performance designs, separate

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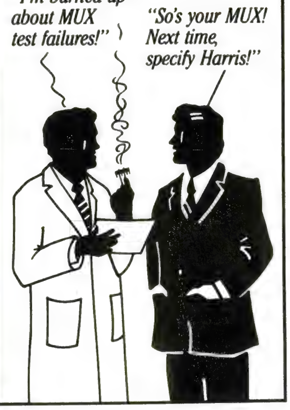
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CIRCLE NO 156

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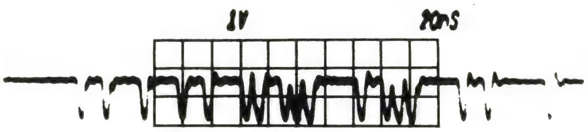

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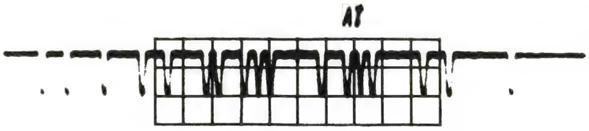

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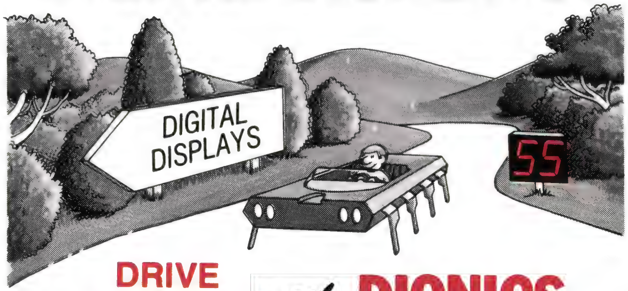

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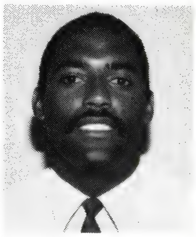
CIRCLE NO 20

power and ground planes are a must. Connect the supply-voltage pins of ICs to the power plane with as short an interconnect as possible to reduce the impedance. Decouple every IC on the board with a 0.1-μF tantalum capacitor, placing it as close as possible to the ground pin of the IC. Route traces on adjacent board layers perpendicular to one another to minimize crosstalk. You should make sure to terminate all lengthy asynchronous traces to reduce reflections. In addition, be aware that if you wire wrap your board, the wiring's increased inductance will increase the ground-bounce voltage. **EDN**

Authors' biographies



Tim Tripp is a product manager at Fairchild Semiconductor Corp's Digital Logic Div (Portland, ME). He directs advertising and all other publicity for the company's Fact family of high-speed CMOS devices; he also directs the design and operations for family growth and support. Tim has a BSEE degree from Notre Dame University. In his spare time, he is an avid sports enthusiast.

Bill Hall is also a Fact product manager at Fairchild Semiconductor Corp (Portland, ME). He is responsible for Fact product-line management and military applications engineering. Bill holds a BSEE degree from Drexel University and is an IEEE member. In his free time, Bill enjoys fishing and golf.

Article Interest Quotient (Circle One)
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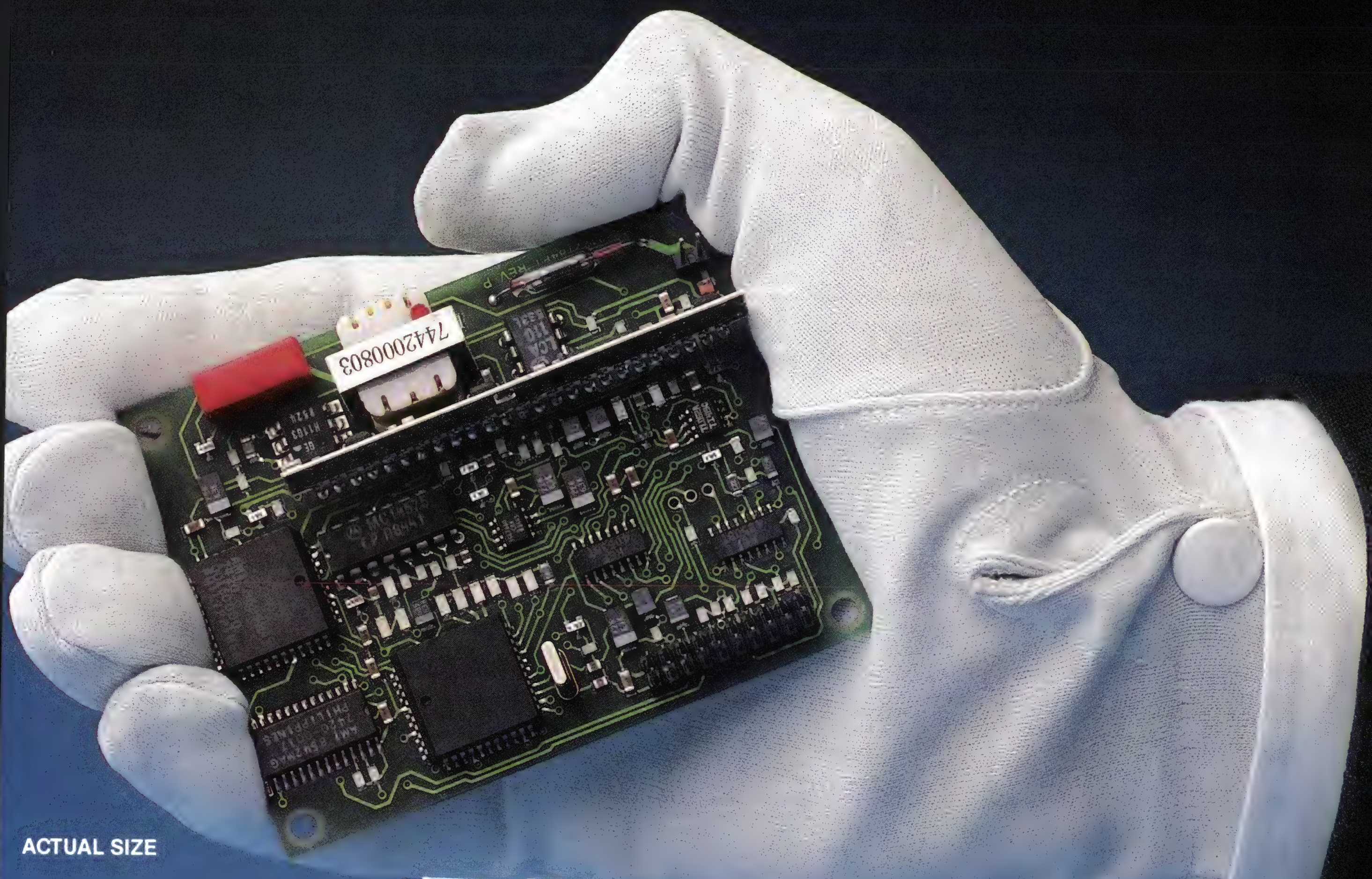

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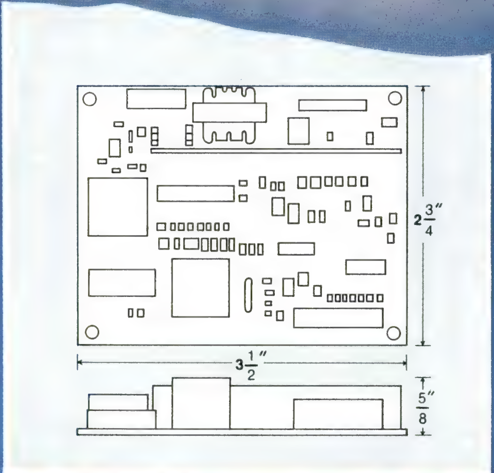

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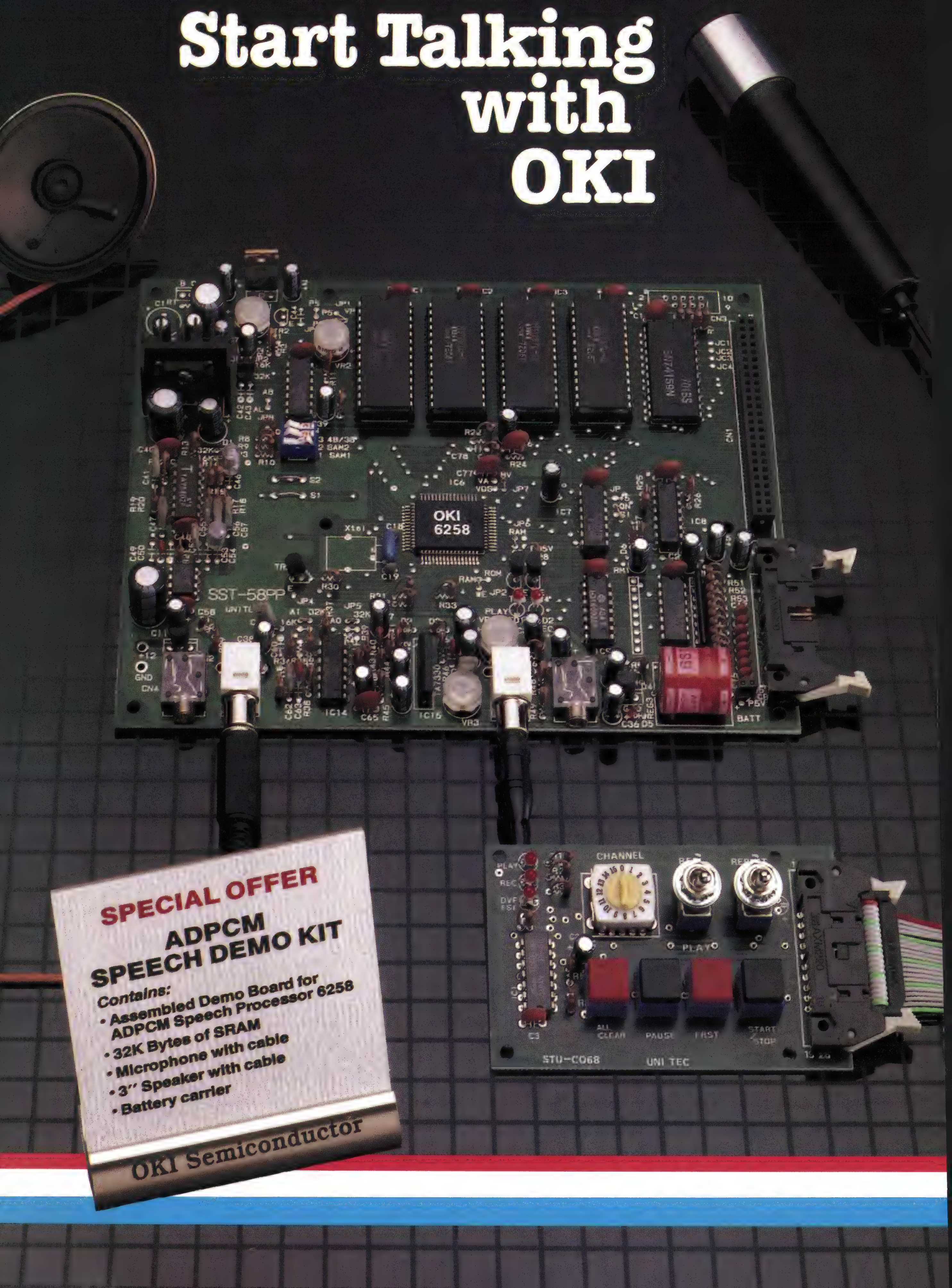

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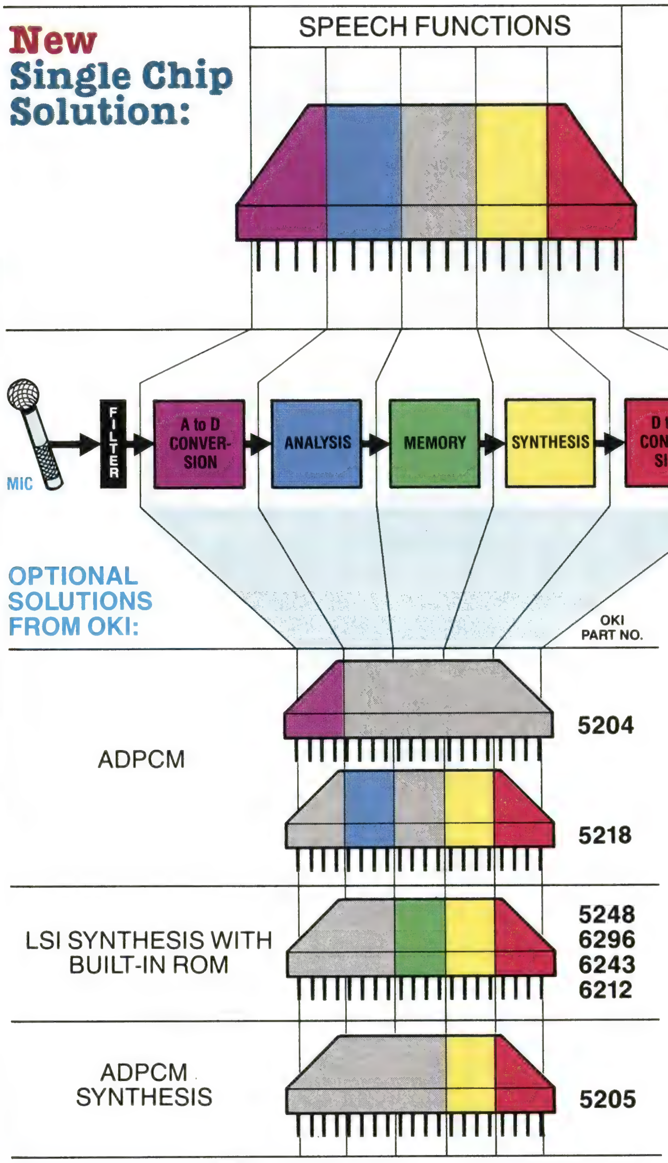

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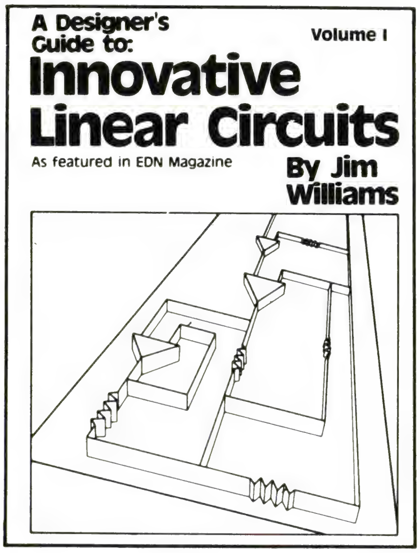

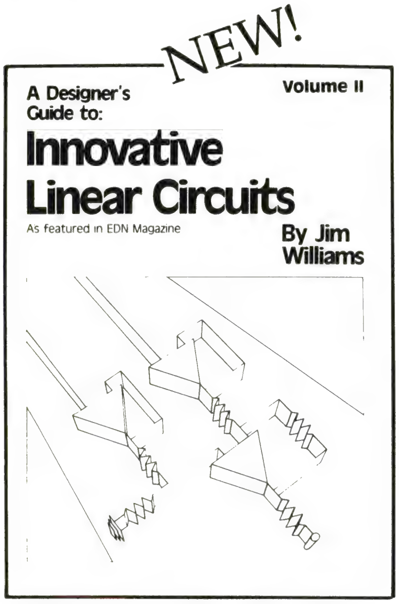

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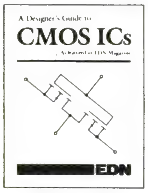

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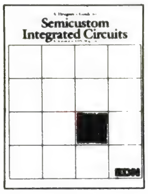

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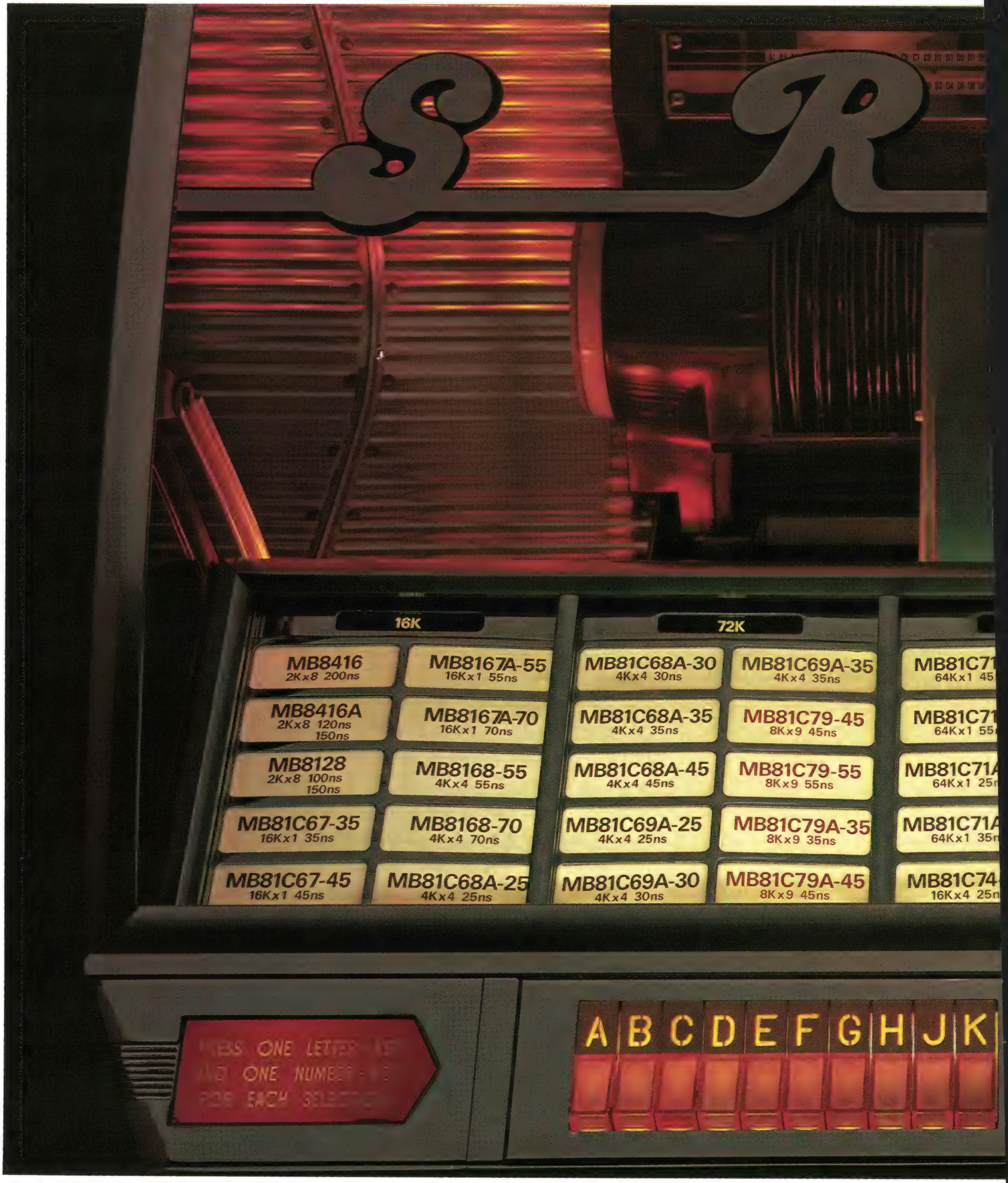

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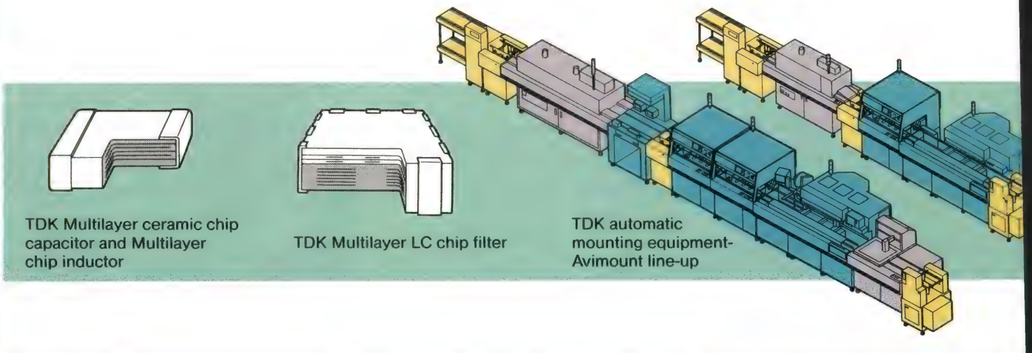
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Sampling of Signals for Digital Filtering and Gated Measurements

William Rempfer

Introduction

For many signal processing applications a sample and hold function is required in a data acquisition system. It is often critical for the processing system to know the exact value of an analog input at an exact time. In DSP applications such as digital filters the usable bandwidth of the system is limited by the Nyquist frequency and the sample and hold bandwidth need only be, and is often intentionally limited to, one half the sampling rate. However, another area of application requires infrequently capturing instantaneous values of relatively fast signals, sometimes referred to as gated measurements. In the extreme case of pulse height measurements, only one sample point is required. Here, the sample and hold bandwidth should be as high as possible even though the sampling rate is very low.

The LTC1090 excels in both environments. This note shows how the LTC1090 sample and hold can be synchronized to an external event and gives two simple applications: an 8 channel data acquisition system with digital filtering, and the gated measurement of a 1MHz sine wave.

The LTC1090 Sample and Hold

The LTC1090 provides a sample and hold which is fast, accurate and can be synchronized to an external event. Although the sampling rate is limited (by the A/D conversion and data transfer rate) to about 30kHz, the signal bandwidth of the sample and hold exceeds 1MHz. The acquisition time is less than 1μs to 0.1% (1LSB). Accuracy is so good, in fact, that it is possible to include all the sample and hold's error contributions (offset, gain, hold step, droop rate, etc.) into the converter specification and still maintain overall system accuracy of ±0.05% (±0.5LSB) over temperature.

Sampling occurs on the falling edge of the last data transfer clock pulse as described in the LTC1090 data sheet. Figure 1 shows a typical application which includes circuitry to synchronize sampling to an external sample clock, f_S.

8-Channel Data Acquisition System with Digital Filter

The circuit of Figure 1 contains an LTC1090 providing multiplexing, sample and hold, A/D conversion and data transfer to the microcontroller (MCU). An MC68HC05C4 is used as the

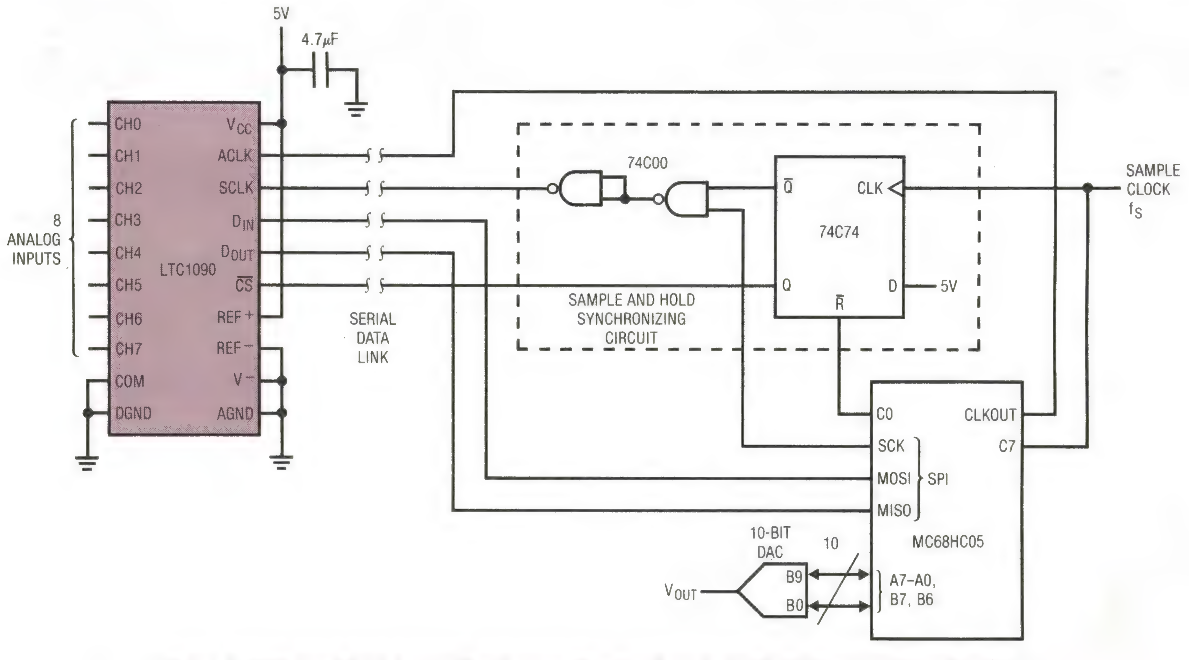

Figure 1. 8 Channel Data Acquisition System Showing Sample and Hold Synchronizing Circuitry

controller (much higher filter performance may be achieved with a dedicated DSP processor). The MCU communicates with the LTC1090 over the serial peripheral interface (SPI), performs the digital filtering algorithm and provides the filtered data on its output port. The DAC provides reconstruction of the filtered waveform for viewing on an oscilloscope or spectrum analyzer. The 74C74 and 74C00 synchronize the sampling of the LTC1090 to the externally applied sample clock, f_S.

In Figure 1, the MCU initiates a two byte serial data exchange with the LTC1090. This configures the LTC1090 for the next conversion, simultaneously reads back the previous conversion result and resets the 74C74. The LTC1090 will sample the analog input when the last shift clock (SCLK) pulse falls, so the MCU must end the data transfer by leaving the SCLK in a high state. This inhibits sampling of the selected analog input. When the sample clock, f_S, rises, it clocks the 74C74 which raises the $\overline{CS}$ and drops the SCLK. This falling SCLK causes the sample to be taken and starts the conversion. After the MCU senses the rising sample clock it waits for the conversion to be completed (44 ACLK cycles) and then initiates another data exchange, preparing the LTC1090 for the next sample. This cycle repeats.

4th Order Elliptic Filter

Using the circuit of Figure 1, a 4th order elliptic digital filter was implemented. 10 bit input and output data words and 14 bit coefficients were used with the same coefficients being used for each channel. A direct form II IIR filter was implemented according the following equations:

$$\begin{aligned} D(n) = {} & [7203 \times D(n-1) - 19209 \times D(n-2) + 6324 \times D(n-3) \\ & - 4383 \times D(n-4)] \times 2^{-14} + X(n) \\ Y(n) = {} & [3069 \times D(n) + 5505 \times D(n-1) + 7824 \times D(n-2) \\ & + 5504 \times D(n-3) + 3066 \times D(n-4)] \times 2^{-14} \end{aligned}$$

where: $X(n)$ = filter input value
$Y(n)$ = filter output value
$D(n)$ = delay node value

The filter frequency response is shown in Figure 2. The cutoff frequency is 175Hz, one fourth the sample frequency of 700Hz. The cutoff frequency of the filter can be tuned by varying the frequency of the sample clock.

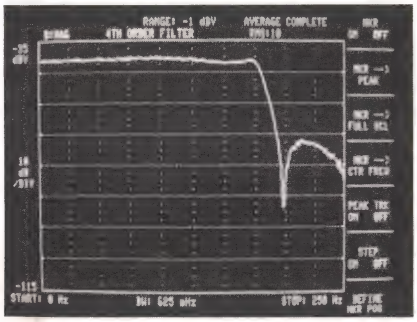

Figure 2. Spectrum of 4th Order Elliptic Digital Filter used in the Data Acquisition System, f_C = 175Hz

Because of 68HC05 speed and instruction set limitations, sample rate is limited by the MCU's ability to perform the DSP algorithm. Maximum sample rate was determined to be 700Hz for a single channel filter and 90Hz for eight channels. Using a high performance DSP would allow sample rates approaching the limit of 30kHz for one channel and 3.7kHz for all eight set by the LTC1090. Hopefully, this simple example will encourage the reader to pursue higher order, higher performance applications.

If large amplitude, unwanted AC signals are present on the inputs, a linear filter such as the LTC1062 can be used to remove them and prevent reduction in the dynamic range of the system.

Gated Measurements of Fast Signals

As an example of gated measurements, the circuit of Figure 1 was used with no filtering to repetitively sample a 5Vp-p 1MHz sine wave. The waveform was sampled at 15kHz (approximately one sample every 67 cycles of the 1MHz waveform). A 20ns pulse, triggered off the sample clock, was applied to the z-axis input of a storage scope to illuminate one dot on the CRT per sample. Samples were allowed to accumulate on the storage scope as shown in Figure 3. The upper waveform is the sampled input to the LTC1090 and the lower waveform is the sampled output of the DAC. (Remember that the waveforms are not real time: one dot was illuminated only every 67 cycles of the 1MHz sine wave.) With this technique the signal bandwidth of the LTC1090 sample and hold was determined to be 2MHz.

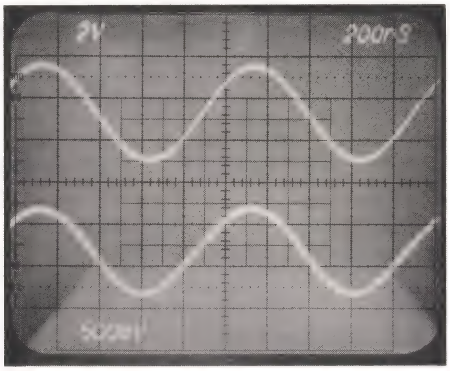

Figure 3. Input and Output Sample Points of a 1MHz Sine Wave Accumulated on a Storage Scope

Using the LTC1090 sample and hold, high speed circuits such as a 1MHz bandwidth AC to DC converter are possible. Because the acquisition time is less than 1μs it is also possible to make a gated measurement of the height of a pulse as narrow as 1μs to 0.1% accuracy.

For LTC1090 literature call **800-637-5545.** For help with an application call (408) 432-1900, Ext. 361.

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DESIGN IDEAS

EDITED BY TARLTON FLEMING

Three ICs combine video and sync signals

Wayne M Austin and D K Tidey
GE Semiconductor, Somerville, NJ

In **Fig 1**, high-speed CMOS inverters and analog switches combine a video signal with the sync and blanking signals produced by the CMOS sync generator IC_1. The result is a fully interlaced-scan, composite-video signal. The circuit works with a monochrome video signal or with the green component of an RGB video signal.

IC_1 offers I/O functions not required in this application. The connections shown enable the IC to accept an external clock signal, and an internal pullup resistor holds pin 20 high. The capacitor C_1 bypasses pin 10 and thereby prevents noise spikes from causing an inadvertent reset of the vertical input. You set the clock frequency to 32× the desired horizontal-sync frequency.

The hex inverter (IC_3) buffers the clock signal and inverts the analog-switch control signals as required. The switches add clamping, blanking, and sync signals to the video. A brief closure of switch IC_{2B} establishes the sync-pedestal amplitude by clamping the video signal at a level determined by the resistor divider R_3/R_4. Closing switch IC_{2C} sets the sync-tip level at V_{SS}, and closing IC_{2D} establishes the black-reference level ("Back Porch"), which you set by adjusting potentiometer R_6. **EDN**

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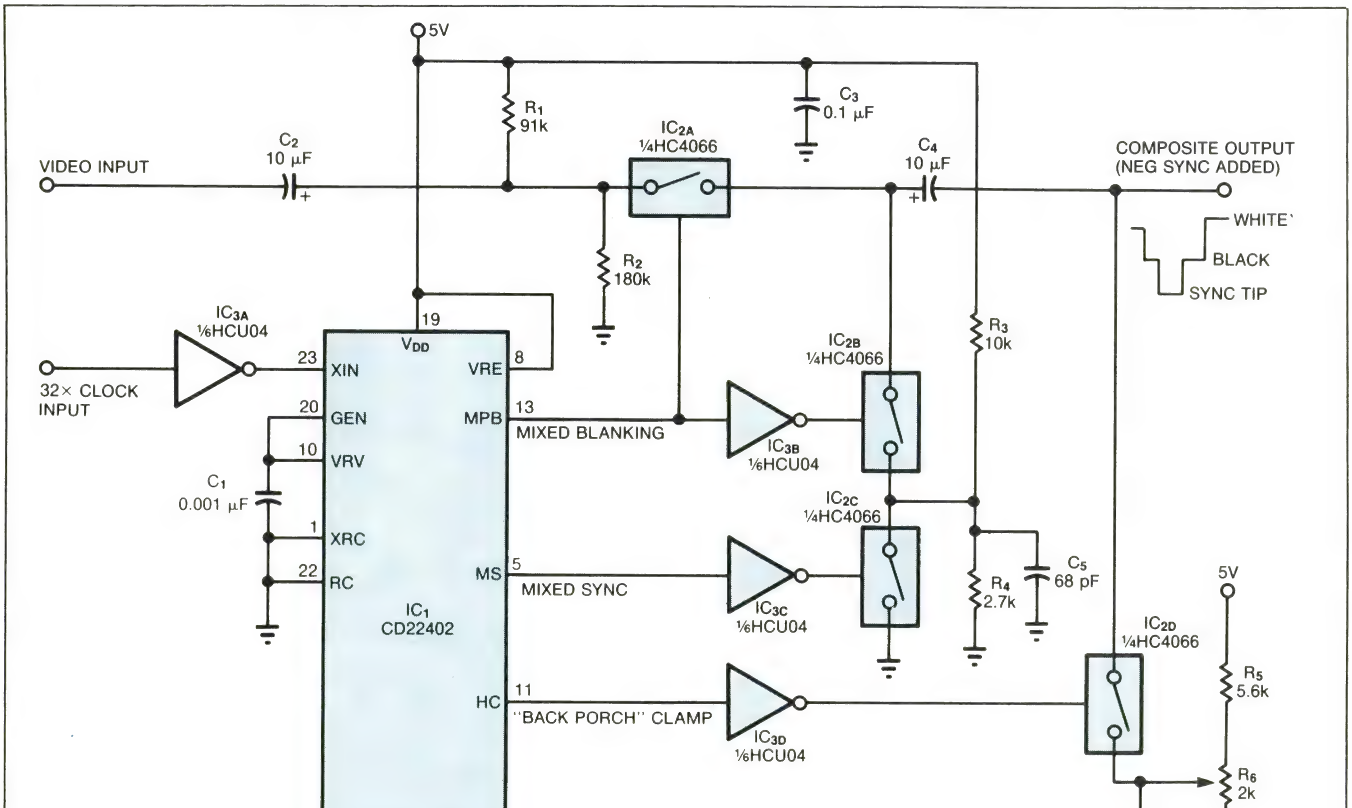

Fig 1—Timing signals generated within IC_1 enable this circuit to generate an interlaced-scan, composite-video signal by combining a video signal with vertical and horizontal sync and blanking pulses.

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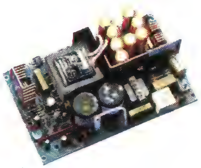

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CIRCLE NO 238

Circuit provides interface for tilt sensor

Steve Momii
University of Washington, Seattle, WA

The **Fig 1** circuit performs level shifting and amplification of the voltage output of an electrolytic tilt sensor. (The sensor consists of a vial whose electrodes are in contact with a conductive liquid. Tilting the vial changes the resistance between the electrodes.)

IC_1 includes two pairs of spdt switches, optimized for switched-capacitor applications and suitable for use in precision dc functions such as instrumentation amplifiers. The chip has an internal 2-phase oscillator that drives the switches at approximately 185 kHz. In this application, the left-hand switches apply square-wave excitation to the tilt sensor. The right-hand switches transfer the resulting signal voltage (V_D) first to capacitor C_2, then to the output amplifier.

Resistor R_1 limits current through the sensor; high current shortens the sensor's life. Capacitor C_1 blocks the dc currents that would otherwise degrade the sensor by plating the electrodes. Op amp IC_2 is a CMOS type whose low bias current has little effect on the voltage across the hold capacitor (C_3).

Voltage V_B provides a reference for the output voltage and a means of calibrating the system offset—you simply have to adjust V_B for the desired V_{OUT} when the sensor is level. When V_B=2.5V, R_2=10 kΩ, and R_3=14 kΩ, the circuit provides a nominal 2.5V output. The resulting (nonlinear) output ranges from 0 to 5V in response to tilt inputs of ±30°. **EDN**

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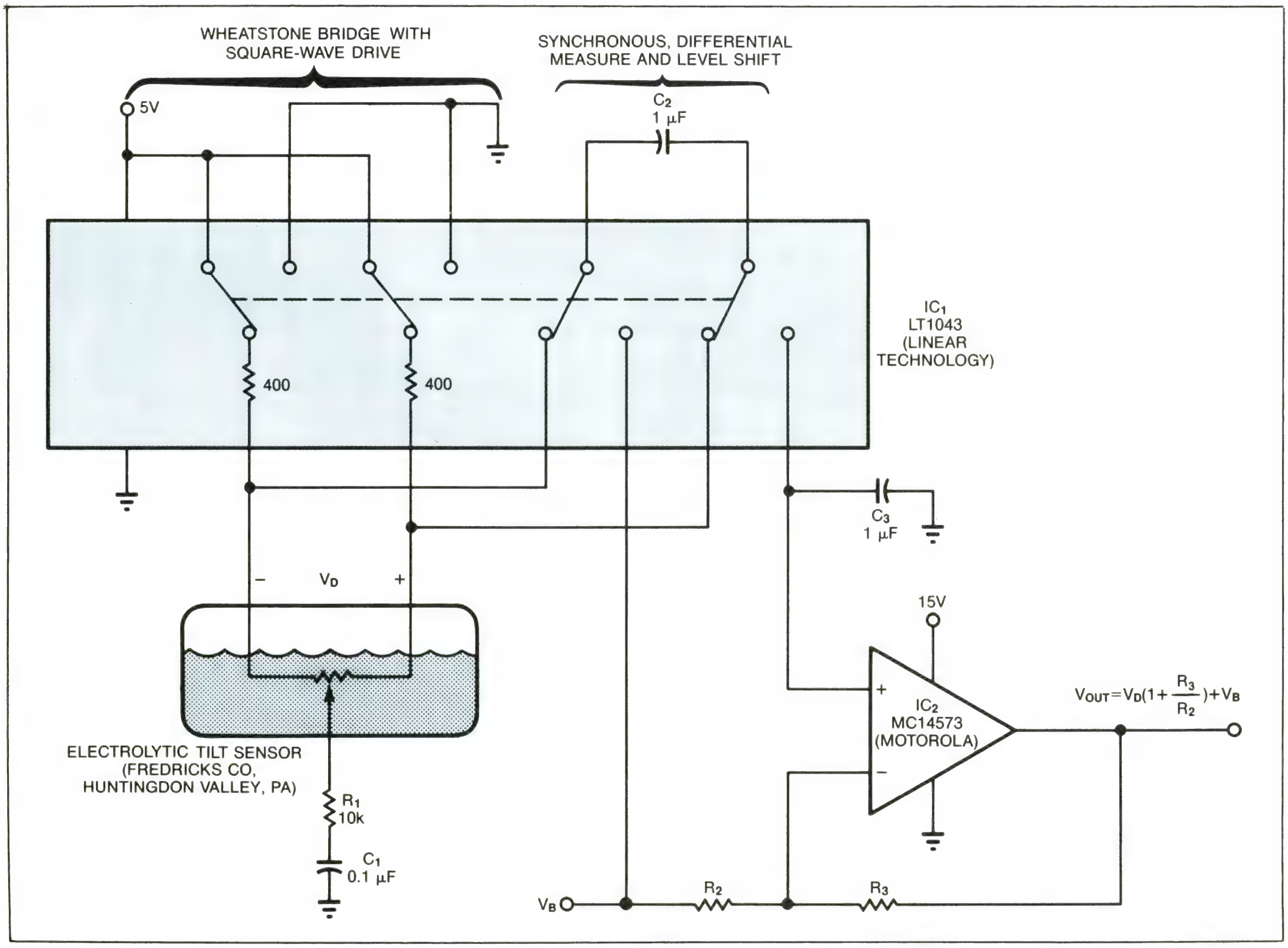
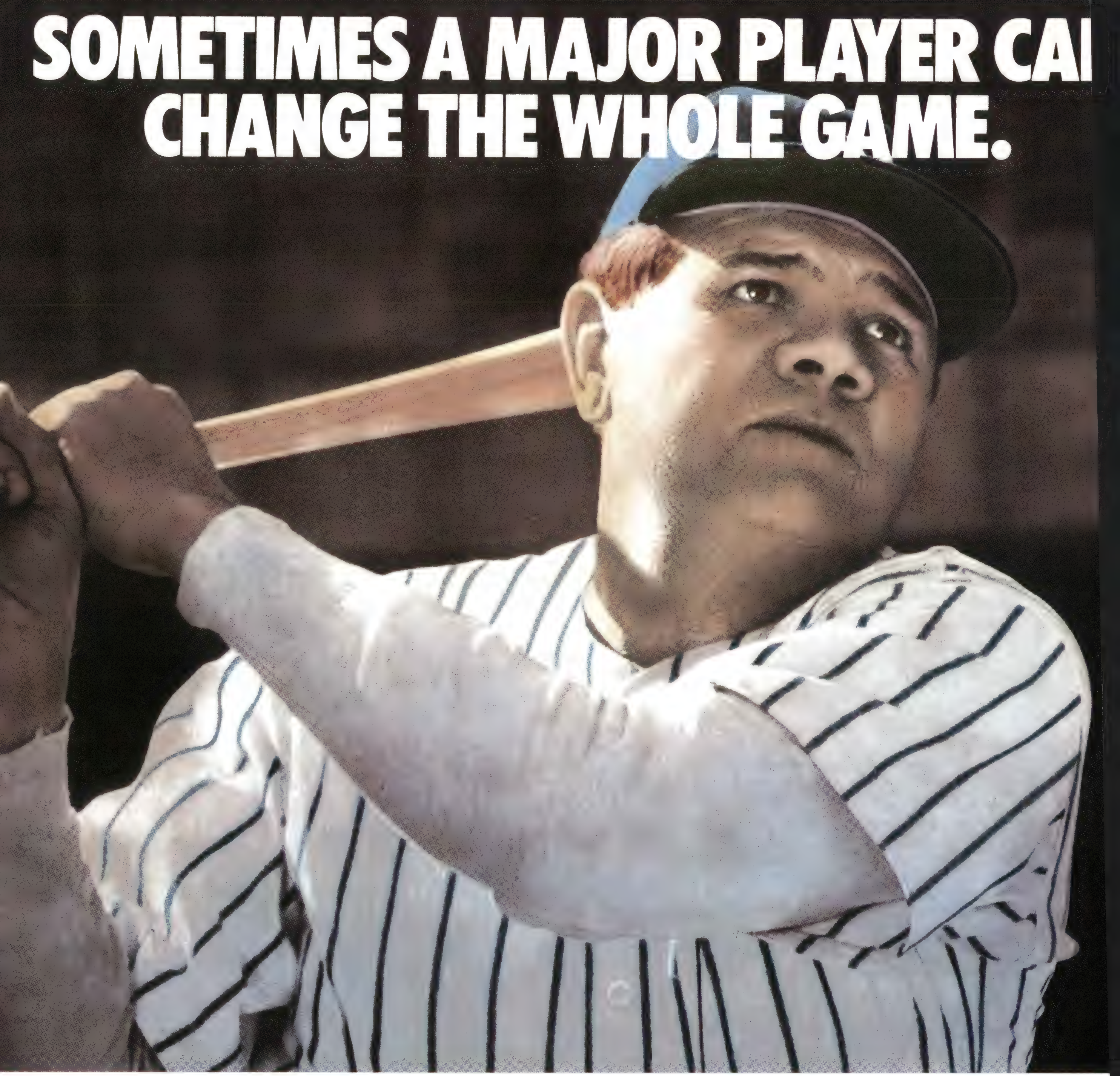

WHEATSTONE BRIDGE WITH SQUARE-WAVE DRIVE
SYNCHRONOUS, DIFFERENTIAL MEASURE AND LEVEL SHIFT
5V
C_2 1 μF
IC_1 LT1043 (LINEAR TECHNOLOGY)
400
400
C_3 1 μF
–
V_D
+
15V
+
–
IC_2 MC14573 (MOTOROLA)
$V_{OUT}=V_D(1+\frac{R_3}{R_2})+V_B$
ELECTROLYTIC TILT SENSOR (FREDRICKS CO, HUNTINGDON VALLEY, PA)
R_1 10k
C_1 0.1 μF
V_B
R_2
R_3

***Fig 1—This tilt-sensor interface** produces a 0 to 5V output in response to tilts of ±30°.*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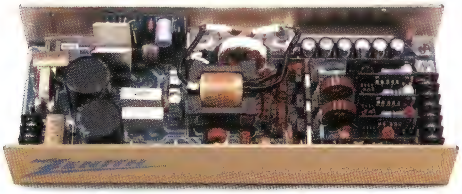

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ZPS-300-N	300	4.75/5.25	4.5/45.0	10.0/15.5	0.8/8.0 PK12	10.0/15.5	0.8/8.0 PK12	4.75/5.25	0.4/4.0	5.0 x 2.5 x 13
ZPS-400-N	400	4.75/5.25	5.5/55.0	10.0/15.5	1.0/10.0 PK15	10.0/15.5	1.0/10.0 PK15	4.75/5.25	0.6/6.0	6.0 x 2.5 x 13

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Simple algorithm detects stuck memory bits

Vance Campbell
Novell Inc, Provo, UT

By performing logical AND and OR operations with appropriate bit masks, the simple algorithm of **Listing 1** detects the position of any bits in a memory array that are permanently stuck. Unlike other test methods such as checksums, the routine also tells you whether a bit is stuck in the high or low logic state. **Listing 1** is written in 68000 assembly language.

First you establish an all-zeros mask and an all-ones mask (of the same widths as the memory under test), and then you initialize the appropriate counters. During execution the algorithm takes each memory word in sequence, performs an OR operation with the all-zeros mask, stores the result in the all-zeros mask, performs an AND operation with the all-ones mask, and stores the result in that mask.

This procedure rapidly fills the zero mask with ones and the one mask with zeros. After program execution, you can assume that any 0 in the zero mask indicates a bit stuck in the low state, and any 1 in the one mask indicates a bit stuck in the high state. You can use the routine for the initial testing of ROMs or for testing RAMs (after first filling the RAM with a known pattern). **EDN**

To Vote For This Design, Circle No 746

LISTING 1—MEMORY-TEST ALGORITHM

```
ROMBase     equ   $f68000       32K of ROM
ROMSize     equ   $3fff         16 K x 16

BitTest:
* Check for stuck bits

        clr.l   d4                      use d4 for zero mask
        move.l  #$ffff,d5               use d5 as ones mask
        move.l  #ROMBase,a0             use a0 as pointer
        move    #ROMSize,d0             use d0 as loop counter

StuckLoop:
        move    (a0)+,d3                d3 is the temporary register
        or      d3,d4                   logical or to zero mask
        and     d3,d5                   logical and to ones mask
        dbf     d0,StuckLoop            loop back until finished

* At this point, any bits still 0 in "zero mask" are stuck at 0, and any bits
* still set in "ones mask" are permanently stuck high. Report to user and exit.

        cmp     #$ffff,d4               any bits stuck low in "zeroes mask?"
        bne.s   StuckLow                if so, go process it

CheckForHighBits:
        tst     d5                      test for zero in "ones mask"
        bne.s   StuckHigh               if not zero, it's an error!

ExitBitTest:
        rts                             back to calling routine

StuckLow:
* User routine to output error message and/or bit mask.

        bra.s   ExitBitTest             exit through common exit point

StuckHigh:
* User supplied routine to handle bits being stuck high.

        bra.s   ExitBitTest             exit through common exit point
```

Debouncer for spdt switches uses few parts

Mounir Boukadoum
University of Quebec at Montreal, Montreal, Quebec, Canada

The debounce circuit of **Fig 1**, applicable to spdt switches, uses fewer components than that of an earlier Design Idea (EDN, March 18, 1987, pg 212). Like the earlier version, **Fig 1**'s circuit has two inverters in a bistable-latch configuration but, unlike its predecessor, it requires no other components.

After assuming a given binary state, the output becomes insensitive to contact bounces thanks to positive feedback around the inverter loop. You can set the circuit output normally high or normally low by connecting IC_{1A}'s input to the appropriate switch contact.

EDN

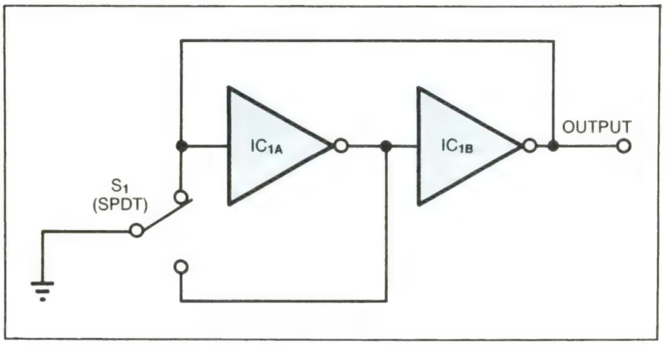

Fig 1—The position of switch S_1 *determines the output state of the bistable latch formed by inverters IC_{1A} and IC_{1B}; positive feedback makes the circuit insensitive to contact bounces.*

To Vote For This Design, Circle No 749

Delay circuit affects leading edge only

Harold J Weber
Effectrol Products Corp, Framingham, MA

The **Fig 1** circuit lets you delay the leading edge of a positive pulse while leaving the trailing edge almost unaffected. A positive input transition, inverted by IC_2, has no effect on IC_{1B}. However, when the positive transition reaches IC_{1A} (delayed by the adjustable network of R_1, R_2, and C_1), it toggles both NOR gates, initiating the output pulse. When the input returns low,

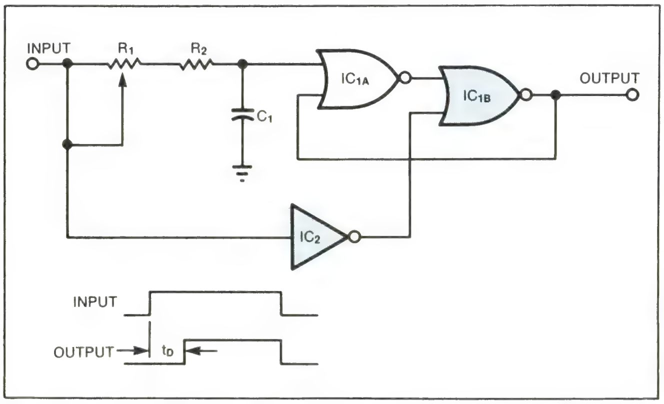

Fig 1—This circuit delays the leading edge *of an input pulse according to the setting of R_1 as shown. The trailing-edge delay equals the propagation delay through IC_2 and IC_{1B}.*

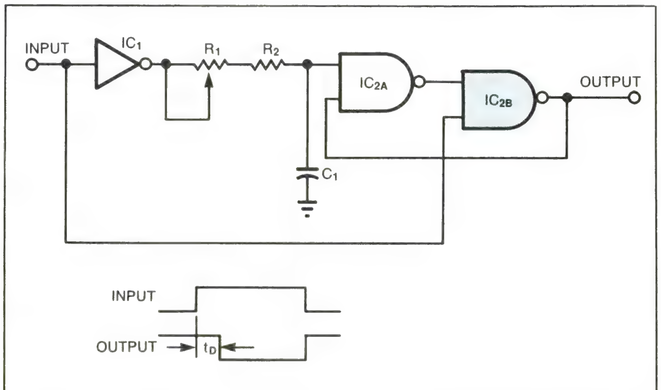

Fig 2—This circuit delays the leading edge *of an inverted pulse and buffers the input signal. The trailing edge is delayed only by the propagation through one gate (IC_{2B}).*

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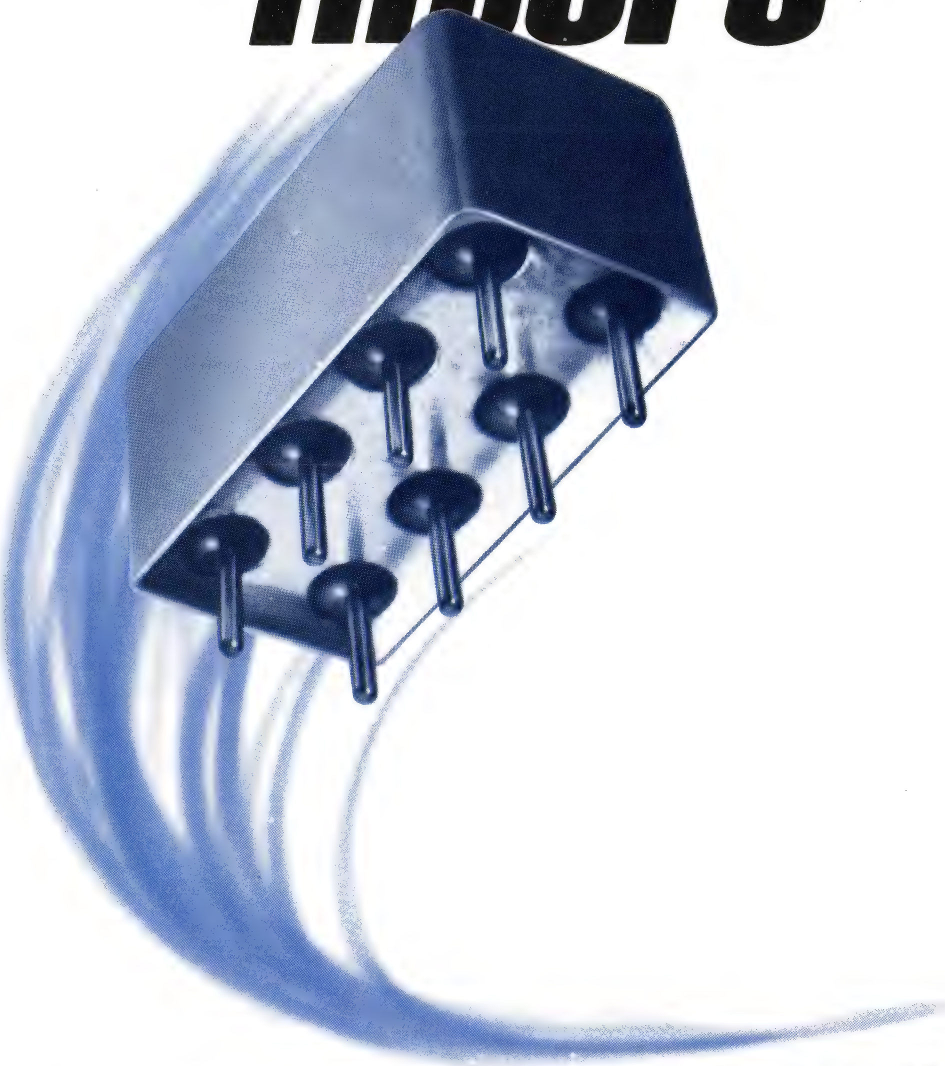
IF bandpass filters



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CIRCLE NO 240

IC_{1B} follows suit, delayed only by the propagation through itself and IC_2.

The **Fig 2** circuit produces an inverted output pulse. Inverter IC_1 serves as a buffer for the signal source—an advantage when driving a low-impedance (short-delay) network. Moreover, only the propagation delay of IC_{2B} separates the output's trailing edge from that of the input.

You can configure **Fig 1**'s circuit to handle negative pulses by using NAND instead of NOR gates. Similarly, **Fig 2**'s circuit will produce a delayed positive pulse in response to a negative input pulse, if you substitute NOR gates for NAND gates. **EDN**

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ISSUE WINNER

The winning Design Idea for the August 6, 1987, issue is entitled "Talking meter gives dc-voltage readings," submitted by Ricardo Jimenez-G of San Diego State University (Calexico, CA), and Francisco Meza and Jose J Lara of Mexicali Technological Institute (Mexicali, Baja California, Mexico).

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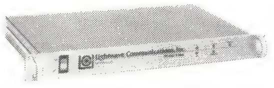

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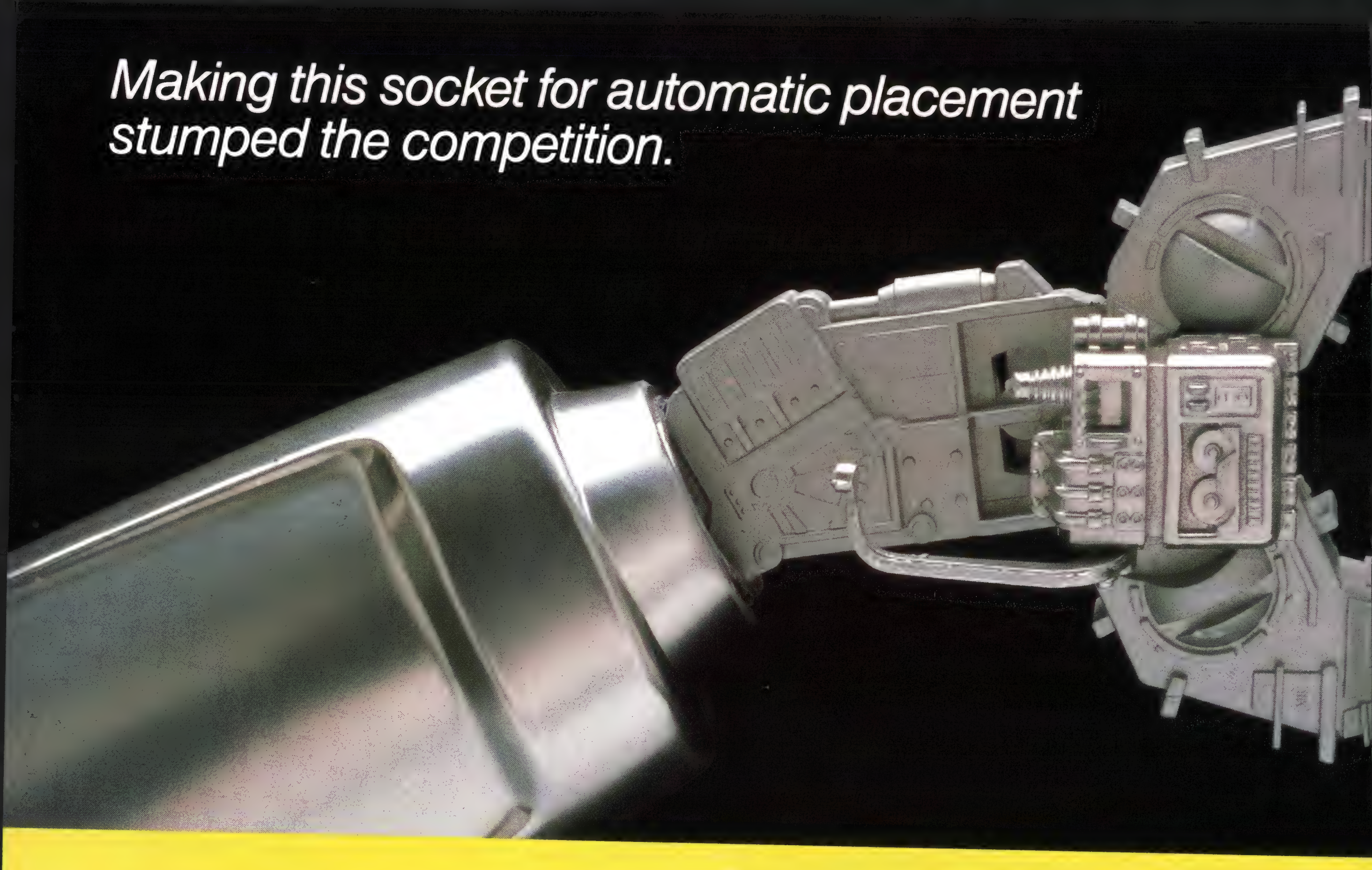
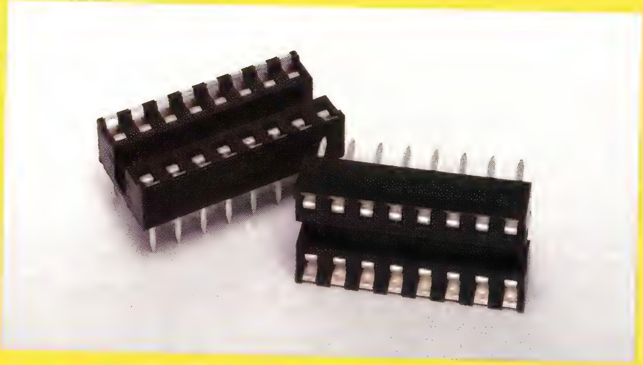
CIRCLE NO 241

Making this socket for automatic placement stumped the competition.



This socket had been made by a major RN competitor. New, more stringent customer specs needed for automatic placement of the socket on PC boards, stumped this supplier as well as many others. The "RN P/Q TEAM", working with customer engineers, responded quickly with modifications of a standard socket that included more precise dimensions and consistent quality in higher production quantities. RN is now delivering precision, high reliability sockets to this major OEM for high speed, automatic assembly.

This is the "RN Partners in Quality Team" in action. It brings all of our engineering, production and quality control resources together with customer experts to solve socket and connector problems with speed and efficiency. Call on the "RN P/Q TEAM" for fast, certain solutions to *your* interconnect problems.

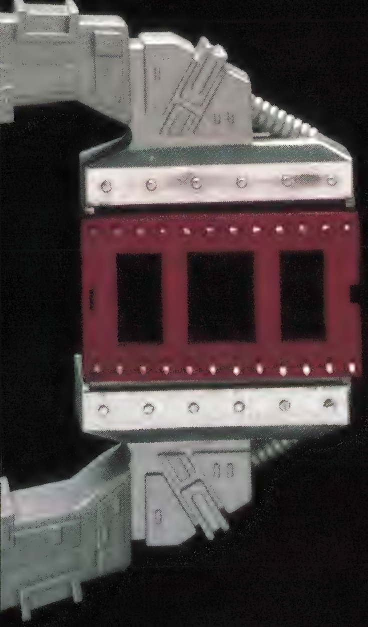


This is the socket that competitors could not make precisely enough to be assembled automatically. It is a modestly priced ICO series DIP socket. RN modified it to rigid customer specs and now produces it in large quantities of unvarying quality that meet the precise requirements of high speed assembly. Just one more example of the RN "Partners in Quality Team" solving difficult customer problems.

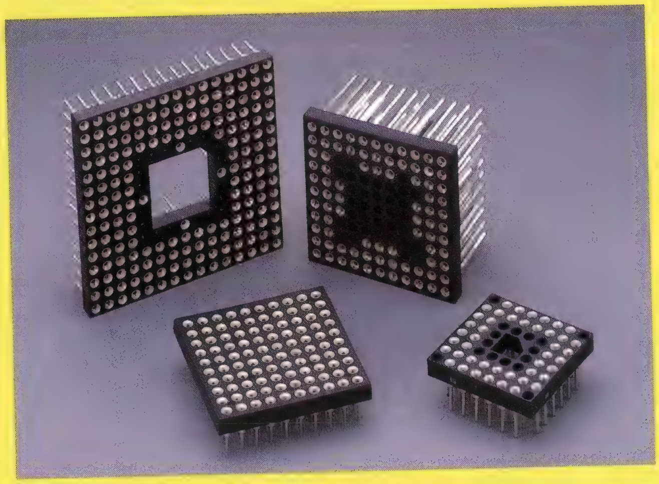
CIRCLE NO 242

Robinson
Nugent

800 East Eighth Street, New Albany, Indiana 47150 • Phone: (812) 945-0211 FAX: (812) 945-0804
In Europe: Rue St. Georges 6, CH 2800 Delemont, Switzerland • Phone: (066) 22 9822 FAX: 011-41-622-9813



The RN "Partners in Quality Team" delivered precision sockets that made automatic assembly possible!



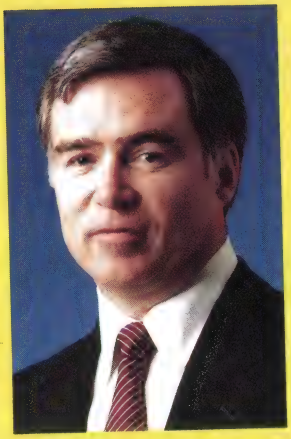
Application Specific PGA Sockets
Robinson Nugent offers a wide variety of Pin Grid Array Sockets for your ASIC's. They feature: High temp bodies for wave soldering • Disposable pin carriers for zero profile contacts • Sizes, 8x8 up to 21x21 with unlimited configurations • Extraction tools available • Molded standoffs for socket body. Write today for complete new PGA catalog.

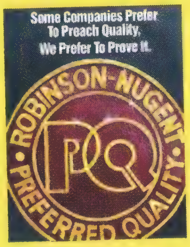
CIRCLE NO 243

"The 'RN P/Q TEAM' concept brings all of our design, engineering and production skills to bear on *your* unique socket/connector problems. We work closely with your people to create solutions that are delivered on-time and defect-free. *You have my personal guarantee on it.*"

R.A. Lindenmuth

R. A. Lindenmuth
President/CEO



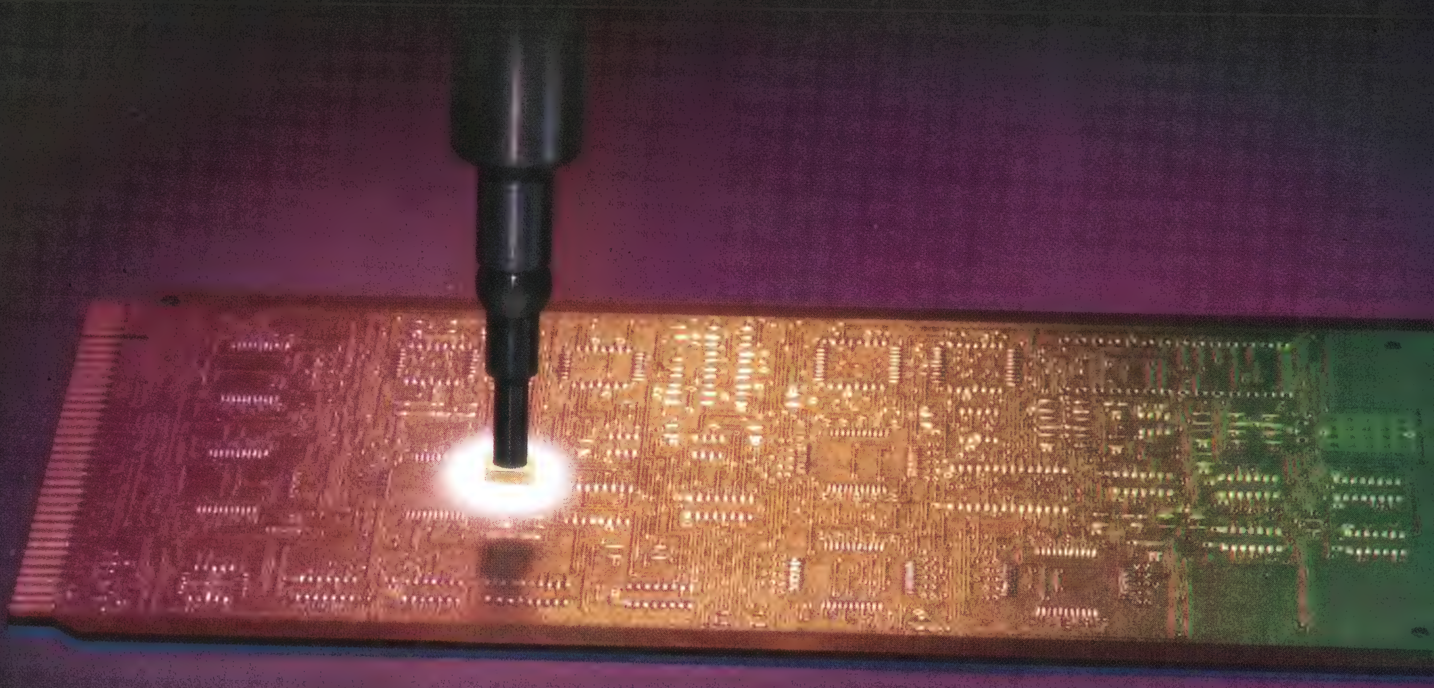

Some Companies Prefer To Preach Quality, We Prefer To Prove It.
ROBINSON-NUGENT
PQ
PREFERRED QUALITY

Write or call today for the comprehensive new brochure: *"The RN P/Q Team in Action".* You'll learn how smart companies are putting the brains, resources and experience of RN engineers to work to solve tough interconnection problems with speed and efficiency.

CIRCLE NO 244

PQ The "RN P/Q TEAM"...your Partners in Quality

WELCOME ABOARD, SURFACE-MOUNT FUSE!



BUSSMANN SMD TRON®

...CURRENT-LIMITING PERFORMANCE IN A MINI PACKAGE.

Bussmann's new SMD Tron is the first current-limiting fuse available for automatic placement and surface mounting. It is fully compatible with standard solder reflow methods. SMD Tron's high-temperature-resistant body survives 60-second exposure to 420°F. The SMD Tron is in a standard JEDEC package, is totally sealed and withstands rigorous board washing. In addition to the economies of state-of-the-art production, this sub-miniature (0.28 in. x 0.17 in. x 0.12 in.) fuse offers substantial time delay with overloads, yet opens very quickly when subjected to heavy fault currents. Its current-limiting capability means extremely low let-through energy under fault conditions. PC Board components are protected. In 1 to 5 ampere ratings. For samples and advance information, call Bussmann headquarters or your nearby Bussmann Sales Engineer, Bussmann Division, Cooper Industries, Box 14460, St. Louis, MO 63178. Phone (314) 394-BUSS.

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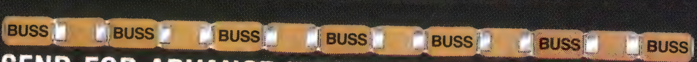
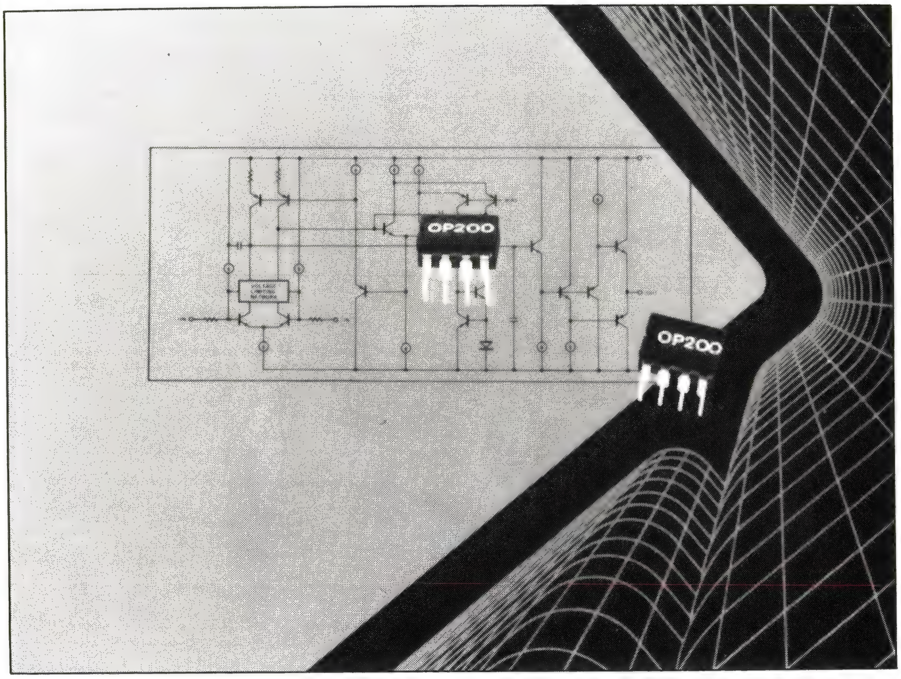


SEND FOR ADVANCE INFORMATION ON SMD TRON.

CIRCLE NO 245



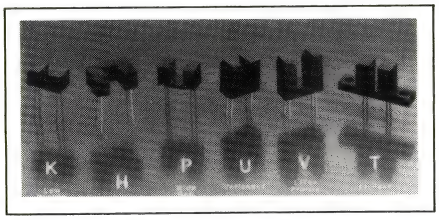
PRECISION OP AMP

- *Low-input offset voltage*
- *Low-offset voltage drift*

Featuring a maximum input-offset voltage of 75 μV and a maximum offset-voltage drift of 0.5 μV/°C, the OP-200 dual op amp consumes less than one-quarter the power of the standard OP-07 on a per-amplifier basis. The maximum supply current for the OP-200 is 1.45 mA (two amplifers) vs 4 mA for the single OP-07. The voltage gain of over 5 million significantly reduces gain error in high-gain applications. Additional specifications include a CMRR of 120 dB and a noise-voltage density of 11 nV/√Hz. Commercial grade, \$2.95; industrial grade, \$3.50; military grade, \$9.80 (100).

Precision Monolithics Inc, Box 58020, Santa Clara, CA 95052. Phone (408) 727-9222. TWX 310-371-9541.

Circle No 351



OPTICAL SWITCHES

- *MOC70 Series with transistor output*
- *MOC71 Series with Darlington output*

These slotted optical switches for motion- and position-sensing come in six package varieties for the MOC70 Series and five varieties for the MOC71 Series. The input LED for both types is an MLED71 with a forward voltage of 0.9 to 1.8V and a typical junction capacitance of 18 pF. For the MOC70 Series, the output transistor has a typical h_{FE} of 700 at 2 mA. The MOC71 Series' Darlington output has a typical h_{FE} of 10,000 at 2 mA. BV_{CEO} for both types is 30V. Turn-on/off times are 20/80 μsec and 120/500 μsec for the MOC70 and MOC71, respectively. \$1.55 to \$1.99 (100). Delivery, stock to 10 weeks ARO.

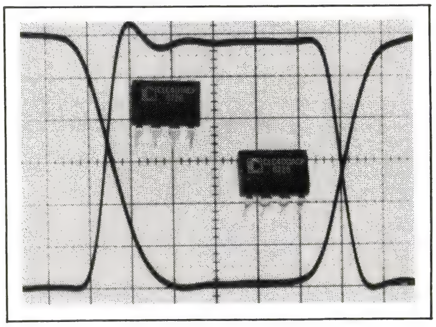
Motorola Inc, Semiconductor Products Sector, Box 52073, Phoenix, AZ 85072. Phone (602) 244-3818.

Circle No 352

WIDEBAND OP AMPs

- *150- and 200-MHz bandwidths*
- *10- and 8-nsec settling times*

Employing a complementary bipolar process, the CLC400 is a high-speed, fast-settling op amp for low-gain applications (gains of ±1 to 8). Its sister chip, the CLC401, is for applications requiring a gain of 7 or greater. With an 8-nsec settling time to 0.05% and the ability to drive capacitive loads, the CLC400 is suitable as a flash A/D driver. The 200-MHz bandwidth and 2.2-nsec rise/fall times ensure good signal fidelity when amplifying high-speed pulses. The CLC401 has a bandwidth of 150 MHz and a settling time of 10 nsec to 0.1%. Both devices have a 50-mA output current rating. Applications include instrumentation, radar/electronic warfare, communications, computers and peripherals, and electronic imaging. Either type in an 8-pin plastic DIP, \$15.50 (100). Delivery, 60 to 90 days.



Comlinear Corp, Box 20600, Fort Collins, CO 80525. Phone (303) 226-0500. TLX 450881.

Circle No 353

NEW

500 to 1600 WATT POWER SUPPLIES

NEW
1600W MULTI

The industry's SMALLEST 1600W Multi output package. ACDC's JFM Series features unlimited flexibility of output voltage & current combinations.

Any combination you choose will be delivered in 2 weeks.

NEW
1000W & 800W MULTI's

Don't compromise on output voltage. ACDC's REV 1000/800W Series has the output combination your design requires.

And you can have it in 2 weeks!

NOT NEW
1500W, 1000W, 750W SINGLES

High performance, competitive pricing and 2 week delivery have made this the most popular "slot" supply in the industry.

Unequivocably.

WATTS	SINGLE	MULTI UP TO 5 OUTPUTS
1600		☐ NEW
1500	☐	
1000	☐	☐
800		☐
750	☐	
500	☐	☐

NEW FEATURES

- IEEE 587 input surge protection
- Current mode control
- Single wire paralleling
- On-board EMI filter (FCC Docket 20780, Class A and VDE 0871, Class A)
- Largest offering of standard options
- Active preload
- Dynamic soft-start
- International safety certifications

NOT NEW

Building quality, reliable power supplies that meet specifications, is not new at ACDC Electronics. We've been doing that for over 30 years.

HIGH POWER COVERAGE

No one else offers such extensive coverage in high power. Check the chart below to solve your 500–1600W power requirements.

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Our power supplies have been PROVEN and PROVEN. Our NEW power supplies are based on these PROVEN designs.

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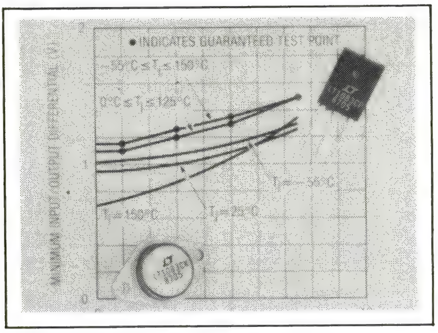
ACDC's POWER OFFERING

CIRCLE NO 246



7.5A REGULATOR

- *Low dropout of 1.5V max*
- *On-chip trimming adjusts reference voltage to 1%*

The LT1083 7.5A adjustable (positive) voltage regulator features a low dropout voltage of 1.5V at maximum-rated output current and is pin compatible with existing 3-terminal regulators. Intended for power regulation within tight enclosures, it can reduce heat-sink and cooling-fan requirements. On-chip trimming adjusts the reference voltage to 1%, and current limiting is trimmed to minimize the stress on the regulator and power-source circuitry under overload conditions. Unlike in pnp regulators, quiescent current flows into the load to increase efficiency. The input-to-output differential is 35V. Typical applications include high-efficiency linear regulators, post regulators for switching power supplies, constant-current regulators, and battery chargers. In TO-247 plastic package, $7.70 (100). Delivery, 30 to 60 days ARO.

Linear Technology Corp, 1630 McCarthy Blvd, Milpitas, CA 95035. Phone (800) 637-5545; in CA, (408) 432-1900.

Circle No 354

NAND-GATE DRIVER

- *Has 60V, 1.5A operation*
- *Draws 8 mA from a 5V supply*

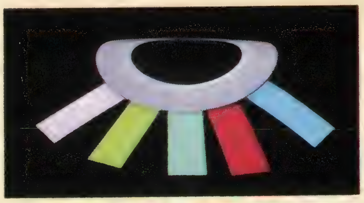
The UDN-2540B is a quad NAND-gate power-driver IC. With outputs disabled and loads disconnected, the device draws 8 mA from a 5V supply or 33 mA from a 15V supply. Each of the independent outputs can withstand 60V in the off state and sink 1.5A in the on state (the maximum-recommended continuous load current is 1.25A, however). You can connect outputs in parallel to obtain higher load current. The device's integral transient-suppression diodes and its minimum 35V output-sustaining voltage suit inductive-load applications. The device is housed in a 16-pin DIP equipped with contact tabs for a heat sink. At 25°C, the package can dissipate 2.7W in free air or 4.5W with a heat sink. $0.97 (1000).

Sprague Electric Co, Box 9102, Mansfield, MA 02048. Phone (617) 853-5000.

Circle No 355

LSI electroluminescent (EL) lamps offer the designer a surface illumination alternative far superior to incandescent or other conventional light sources. And, whereas other makes of EL lamps may offer some of our product features, comparative tests prove that for long life, brightness, uniform light diffusion, color stability, resistance to moisture, heat, vibration and shock, no other EL lamps can match ours.

Thin, flexible and lightweight— Many shapes, sizes and colors
These rugged, solid-state EL lamps provide cool, uniform light across the entire lamp surface, eliminating the need for sockets, bulbs, diffusers and reflectors. Power consumption is small due to low current demand. A thin profile (.032″) permits high density packaging; and with IC-style leads available, lamps are compatible with PCBs. Although stocked in rectangular shapes for immediate delivery, we can design EL lamps in a variety of custom shapes and sizes including complex forms with multiple holes and cutouts. Available with pressure-sensitive adhesive on front or rear surfaces.



If you'd like a copy of our brochure, or have questions regarding EL applications, just call, write or TWX the LSI Marketing Department.

Luminescent Systems Inc.
Setting the Standard

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Etna Rd., Lebanon, NH 03766

CIRCLE NO 22

IWATSU ADDS TWO NEW DIGITAL STORAGE OSCILLOSCOPES

The new 60 MHz DS-6612 and 40 MHz DS-6411 both have large-capacity 16 K word memory, digital persistence display, GO/NO GO judgements, direct hardcopy output to a plotter, plus dual A/D converter operating at 20 MS/s (DS-6612) and at 10 MS/s (DS-6411). These two new models feature the best price/performance in the industry.

	NEW DS-6411	NEW DS-6612	DS-6121A
Max. Sampling Rate	10 M S/s	20 M S/s	40 M S/s
Equivalent Time Sampling BW	None	60 MHz	100 MHz
Analog Bandwidth	40 MHz	60 MHz	100 MHz
Capture Memory Length	1 or 16 k/CH	1 or 16 k/CH	2 k/CH
Glitch Capture	200 ns	100 ns	50 ns*
Vertical Resolution	8 bit	8 bit	8 bit
CRT Readout/Cursors	YES	YES	YES
GP-IB/RS-232C (options)	YES ($500)	YES ($500)	YES ($750)
3-year Warranty (U.S.A. & Canada)	YES	YES	YES
Price (U.S.A. only)	$2,570	$3,795	$5,475

*Also available: Model DS-6121 (without Glitch/Envelope mode) $ 4,975

DS-6411/6612

Both models feature easy-to-learn, easy-to-use Menu-Driven operations, pre/post-triggering capabilities, averaging and much more.

U.S.A. & Canada

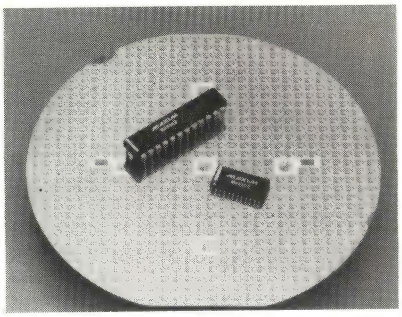
IWATSU INSTRUMENTS INC.

430 Commerce Boulevard, Carlstadt, NJ 07072 TEL: (201) 935-5220 FAX: (201) 935-2075

Japan & Other Countries

IWATSU ELECTRIC CO., LTD.

TOKYO, JAPAN



12-BIT CMOS ADC

- *Has 3-μsec max conversion time*
- *High-speed digital interface*

The Max162 fast, 12-bit successive-approximation ADC features a 3-μsec max conversion time when operating with a 4-MHz external clock. Included on-chip are a zener reference, 3-state output drivers, μP interface circuitry, and internal or external clock options. It operates from 5V and −15 or −12V supplies and provides an analog input range from 0 to 5V. The high-speed digital interface and 3-state outputs allow the Max162 to operate with most widely used μPs. Applications include high-speed data acquisition, ATE, process control, and digital signal processing. It's available in three temperature ranges. $46 to $165 (100).

Maxim Integrated Products, 510 N Pastoria Ave, Sunnyvale, CA 94086. Phone (408) 737-7600.

Circle No 356

SOUND CONTROLLER

- *Controls volume, balance, bass, and treble in stereo systems*
- *Suitable for audio systems, car radios, and TV receivers*

Using dc input-control signals the CA3259 can control the volume, balance, bass, and treble outputs in a stereo sound system via inexpensive potentiometers or a programmable remote-control system. Each channel contains a preamp and amplifiers for treble, bass, and volume/balance. The bass and treble responses are controlled by external capacitors. The volume range is 75 dB, the tone control range is 14 dB, and the typical distortion is 0.1%. The channel separation is a minimum of 45 dB. $2.75 (500).

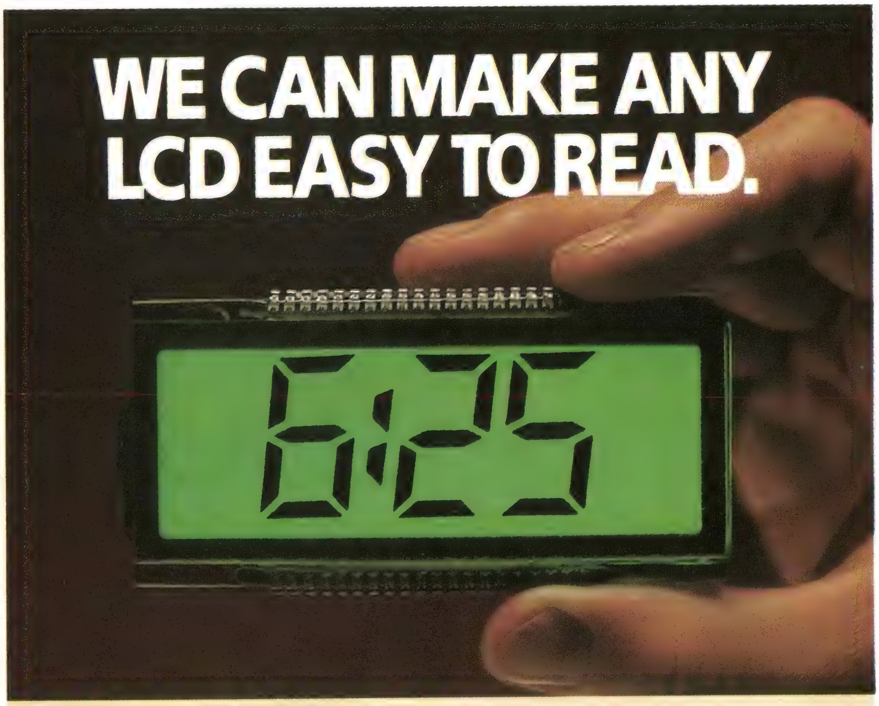
GE/RCA Solid State, Rte 202, Somerville, NJ 08876. Phone (201) 685-6713.

INQUIRE DIRECT

D/A CONVERTER

- *Provides 12-bit resolution*
- *Specifies a 35-nsec settling time*

The AD568 is a 12-bit, monolithic D/A converter that settles to within ±0.025% of full scale in typically 35 nsec. The current-output device (10.24 mA full scale) is suitable for use in waveform generation, video



Our thin, flexible electroluminescent lamps dramatically improve LCD readout by providing higher contrast and better visibility. A thin profile (.032") allows high density packaging, and pressure-sensitive adhesive can be supplied on front or rear surfaces for rapid assembly.

Uniform, cool light source in many shapes, sizes and colors
Our backlighting ELs emit even illumination across the entire lamp surface. They also eliminate the need for sockets, bulbs, diffusers or reflectors. Lamps are usually supplied in rectangular shapes, but we can create many custom shapes and sizes including complex forms with multiple holes and cutouts. With IC-style leads, lamps are compatible with PCB assembly. Eight standard colors are available and custom colors can be created.

If you'd like more information relating to LCD applications, just call, write or TWX the LSI Marketing Department.

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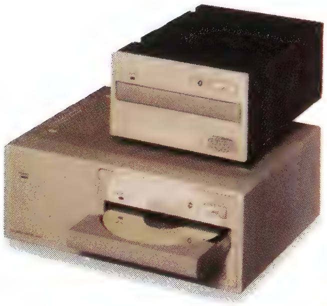
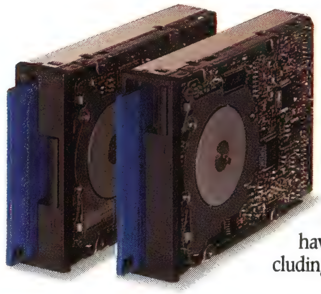
CIRCLE NO 23

If this is what comes to mind when you think Sony,

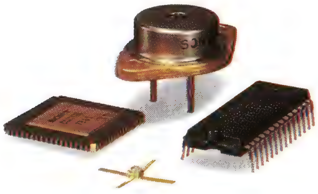
Think again.



CD ROMs. From the company that pioneered optical memory technology come CD ROMs in built-in and stand-alone models. Also look for a half-height model coming soon.



Disk drives. We're the industry leader in 3.5-inch Micro Floppydisk drives and have over 18 versions available. Including an all-new 2-megabyte drive.



Semiconductors. You'll find a diverse selection of SRAMs, HEMTs, laser diodes and A/D and D/A converters. Each with the leading-edge performance you demand.

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Graphic Displays. Let Sony's advanced TV technology benefit your OEM needs. You'll find everything from four-inch flat displays up to 19-inch high-resolution monitors.

Everyone knows that Sony makes TVs. But few know we make component products for the OEM market, too.

Fact is, we're a primary component supplier to a broad range of OEMs—from small start-ups to major Fortune 100 companies. Supplying a complete range of component products, each with some of the highest performance specs you'll find anywhere.

To discover how Sony component products can help bring your designs into sharper focus, write Sony Corporation of America, Component Products Group, 10833 Valley View St., Cypress, CA 90630, Attn: Sales. FAX (714) 229-4271. Or call the Sony representative nearest you.

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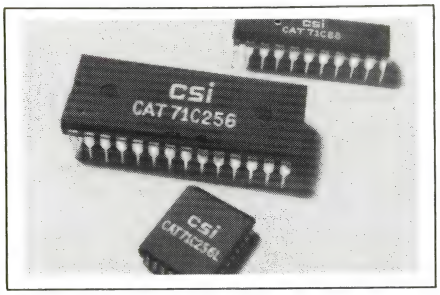
WI Waukesha (414) 542-5352

CIRCLE NO 249

graphics, and as a component in high-speed successive-approximation A/D converters. The part is the first offering to employ the vendor's proprietary complementary-bipolar process, which combines high-speed npn and pnp transistors on the same chip. The converter has a buried-zener voltage reference and a user-variable input-logic threshold; onboard resistors provide output-voltage ranges of 0 to 1.024V and ±0.512V. The device comes in a 0.3-in.-wide, 24-pin ceramic DIP, requires ±13.5 to ±15V supplies, and dissipates 525 mW. From $35 (100).

Analog Devices, Literature Ctr, 70 Shawmut Rd, Canton, MA 02021. Phone (617) 935-5565.

Circle No 358



CMOS STATIC RAMs

- *Organized as 256k bits*
- *Low-power version has 100-μA standby current*

The 32k×8-bit CAT71C256 and CAT71C256L CMOS static RAMs have an 85-nsec access time, which, according to the manufacturer, is the highest speed available in a 256k-bit static RAM. Standby currents are 1 mA for the CAT71C256 and 100 μA for the low-power CAT71C256L. Each device is available in either a 28-pin DIP or a 32-pin PLCC, operates from a 5V supply, and features TTL-compatible inputs and outputs. CAT71C256, $18.25; CAT71C256L, $20.62; CAT71C88, $8.55 (100).

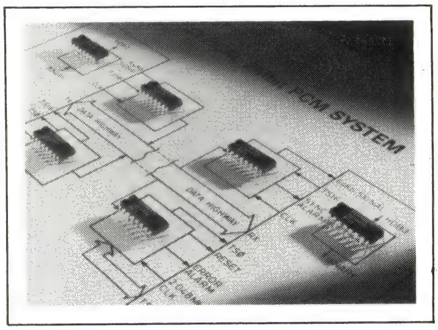
Catalyst Semiconductor Inc, 4051 Burton Dr, Santa Clara, CA 95054. Phone (408) 980-9144.

Circle No 359

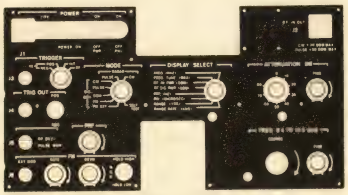
CHIP SET

- *Provides signaling and error detection for PCM links*
- *Pin and function compatible with MJ1440 Series devices*

The ZN1440 chip-set series, consisting of four ICs, performs all the common signaling and error-detecting functions required in a 2.048M-



At only .085" thick, our new fiberglass electroluminescent panels are designed to replace lightplates and traditional metal plates that may not presently be illuminated. Our thin .085" panels weigh 40% less than a typical .220" plexiglass panel, and with an expansion coefficient equal to aluminum, the panels are ideal for surface-mount applications.


LSI electroluminescent panel

As the pioneer developers of EL lamps, as well as the process of encapsulation, we have combined the uniform, cool surface illumination of EL with the strength of fiberglass to create a new standard for panels.

Durability and long life luminescence
LSI EL lamps eliminate the need for sockets, bulbs, diffusers or reflectors, and add no heat to the assembly. This, together with their long life and availability in many colors, make them the intelligent choice for panel illumination – far superior to LEDs or incandescent bulbs. We create panels (including standard .220" plexiglass) in almost any shape and size, as well as complex designs with multiple holes and cutouts. Lamps can be filtered to comply to ANVIS or other military specifications, or to your design requirements.

If you'd like a copy of our brochure, or have questions regarding panel applications, just call, write or TWX the LSI Marketing Department.

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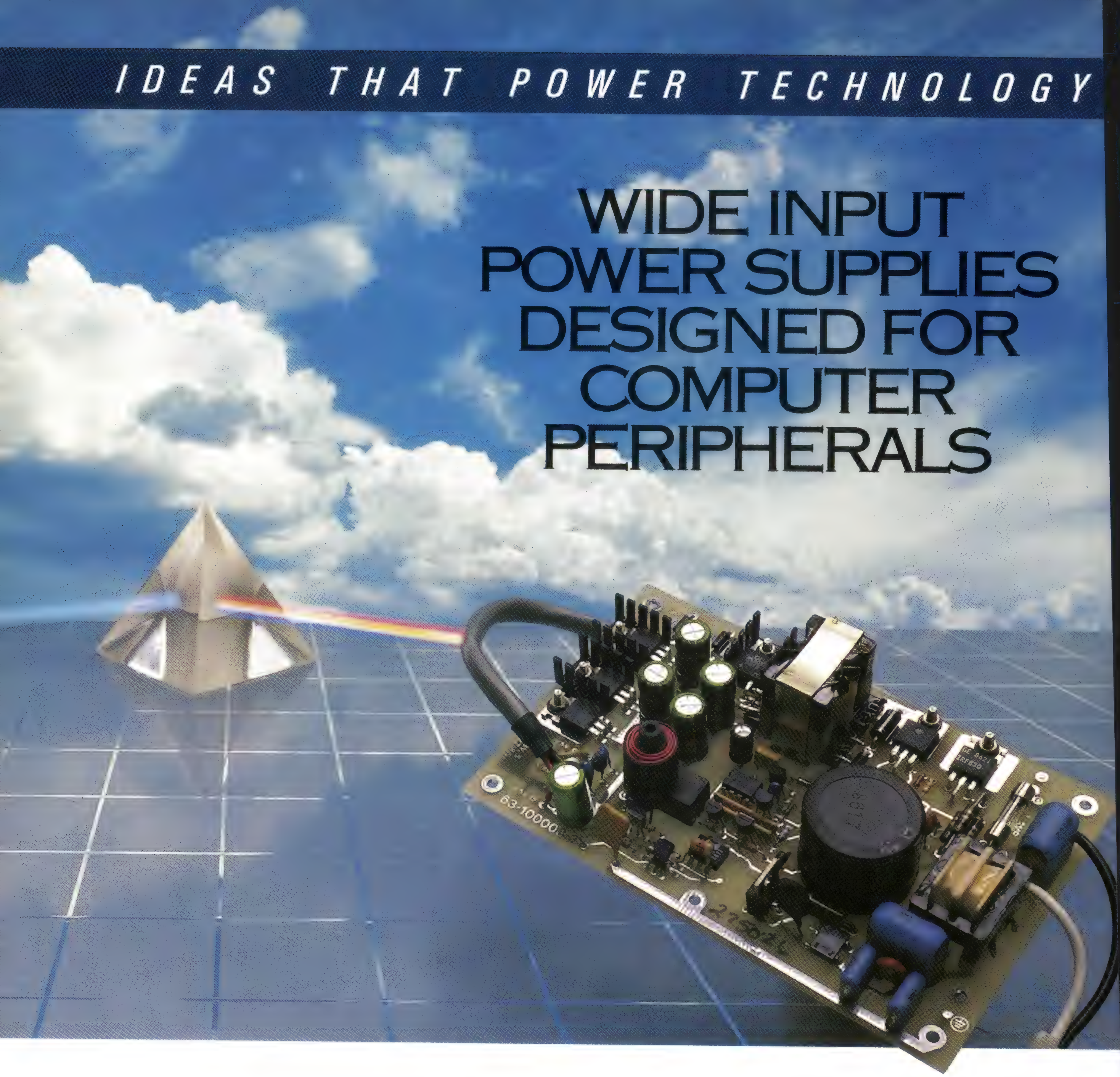
CIRCLE NO 24



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CIRCLE NO 25

bps, 30-channel PCM transmission link. All the devices conform to the appropriate CCITT recommendations. The ZN1440E simultaneously and asynchronously encodes and decodes data in the link's HDB3 format and detects any coding errors. At the link's transmission end, the ZN1444E generates a synchronizing word and injects it into the PCM data highway during time-slot 0 of alternate transmission frames. At the receiving end of the link, the ZN1445E detects the frame synchronization word and synchronizes the receiver. It also flags synchronization errors. The ZN1446E operates at either end of the link, transmitting or receiving signaling information during each frame's time-slot 16. It accepts information in either binary or AMI format. The chips are available in either ceramic or plastic 16-pin DIPs and are pin and function compatible with corresponding MJ1440 Series devices. ZN1440E and ZN1445E, each $6.20; ZN1444E, $10.18; ZN1446E, $7.38 (1000).

Ferranti Electronics Ltd, Fields New Rd, Chadderton, Oldham OL9 8NP, UK. Phone (061) 624 0515. TLX 668038.

Circle No 360

Ferranti Electric Inc, 87 Modular Ave, Commack, NY 11725. Phone (516) 543-0200. TLX 6852104.

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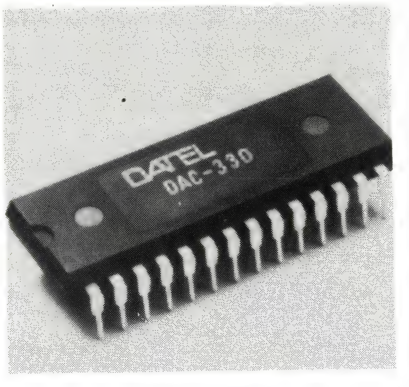
10-BIT VIDEO DAC

- *160-MHz conversion rate*
- *14-MHz multiplying bandwidth*

Designed for ultrafast applications such as graphics displays and high-speed signal processing, the DAC-330 is a monolithic 10-bit, 100-MHz, multiplying D/A converter with a 14-MHz multiplying bandwidth capability. It operates from a −5V power supply and dissipates a maximum of 1.48W. Its digital inputs are ECL compatible, and you can invert the proportional relationship between input data and output voltage. The output voltage range is 0 to −1.0V, with a settling time of 4.7 nsec. The operating temperature range is −20 to +75°C. It comes in a 28-pin plastic DIP. $112.



Datel, 11 Cabot Blvd, Mansfield, MA 02048. Phone (617) 339-9341. TWX 710-346-1953. TLX 951340.

Circle No 362

FIFO MEMORIES

- *Offer 64-word×4- or 5-bit organizations*
- *Operate over 10 to 45 MHz*

Four CMOS FIFO memories are available. The IDT72401 and IDT72403 (identical to the IDT72401 except it has an extra output-enable function) come in a 64-word×4-bit organization, and the IDT72402 and IDT72404 (also with the extra output-enable function) come in a 64-word×5-bit configuration. All are asynchronous devices, available in 10-, 15-, 25-, 35-, and 45-MHz versions. A RAM-based architecture provides a 25-nsec fall-through time (compared with 1 μsec or more for bipolar devices). The typical power dissipation is 200 mW, or less than ⅕ that of bipolar types. The chips provide both asynchronous and simultaneous shift-in/shift-out operations. You can cascade the chips to achieve greater word depth or bit width. From $15 (100).

Integrated Device Technology Inc, Box 58015, Santa Clara, CA 95052. Phone (408) 727-6116. TWX 910-338-2070.

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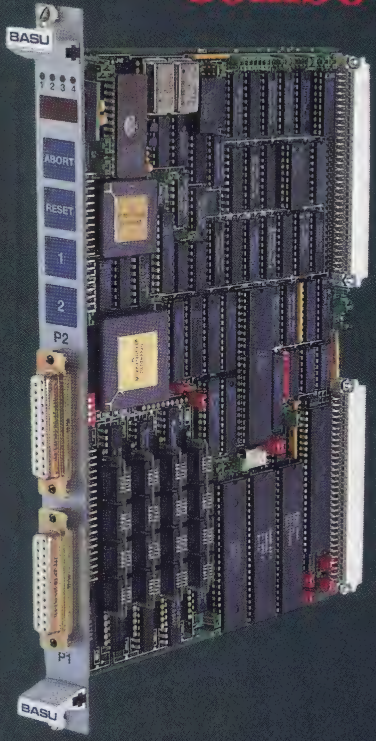
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- *Combines sample/hold and A/D converter*
- *Has max 500k-sample/sec throughput*

The ZAD2764 sampling A/D converter combines a sample/hold amplifier with a 2-pass, digitally corrected, subranging A/D converter with 14-bit resolution. Intended for applications in instrumentation, ATE, and medical-imaging systems, the device has a maximum throughput rate of 500k samples/sec. Its A/D-conversion time is 0.9 μsec. Its package measures 3.8×4.5×0.55 in. $496 (100). Delivery, four to six weeks ARO.

Analog Solutions, 85 W Tasman Dr, San Jose, CA 95134. Phone (408) 433-1900.

Circle No 364

HIGH-SPEED μP

- *Operates at 16 MHz*
- *Compatible with lower-speed versions*

The 80286-16 is a 16-MHz version of the 80286 μP, which boosts system performance nearly to the level of 80386-based systems. The 80286-16, a continuation of the manufacturer's line of 8-, 10-, and 12.5-MHz 80286 μPs, provides a 28% speed increase over the 12.5-MHz version. The device is compatible with the lower-speed versions. The manufacturer claims that the 80286-16's bench-

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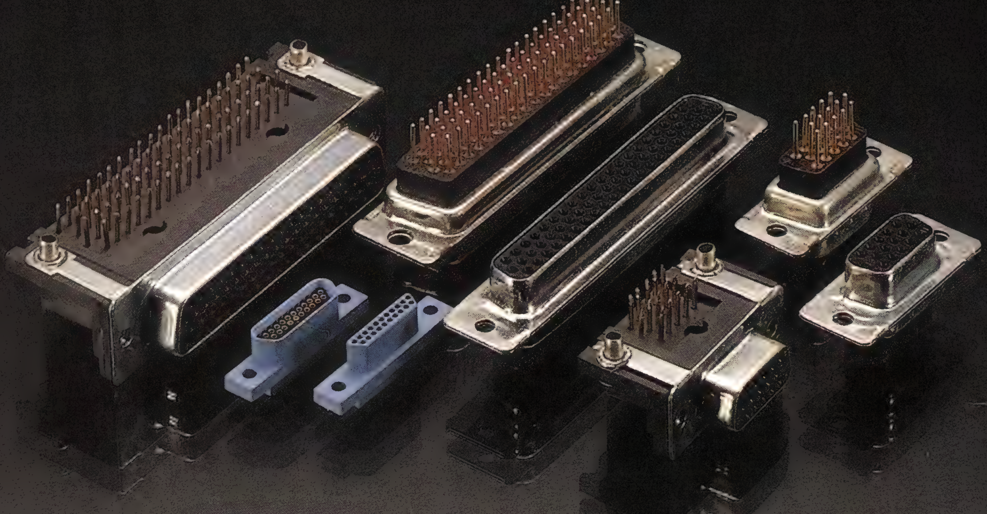

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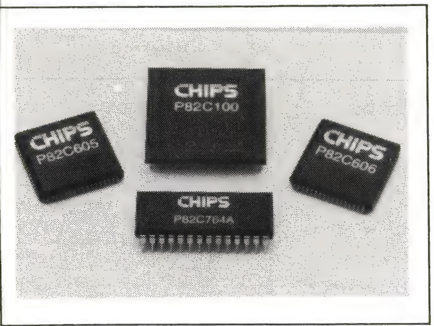

PS/2 CHIP SET

- *Compatible with IBM PS/2 Model 30 and PC/XT*
- *Supports 8088/V20 and 8086/V30 microprocessors*

The 82C100 system-control chip supports 8088/V20 and 8086/V30 microprocessors at speeds to 10 MHz and is targeted for high-performance IBM PS/2 Model 30s, PC/XTs, and compatible computers. It includes a memory controller that supports the Lotus-Intel-Microsoft expanded memory specification and offers power-management features for laptop systems to help reduce battery consumption. The 82C101 chip supports 8088 and V20 8-bit processors. It's aimed at lower-cost PC/XT-compatible computers and terminals and does not include power-management features. The three companion chips are the 82C606 Chipspak and the 82C605 Chipsport—both multifunction peripheral controllers and the 82C764A floppy-disk data separator. 82C100, $51.30; 82C101, $41.10; 82C606, $23.40; 82C605, $17.60; 82C764A, $7.80 (100).

Chips and Technologies Inc, 521 Cottonwood Drive, Milpitas, CA 95035. Phone (408) 434-0600.

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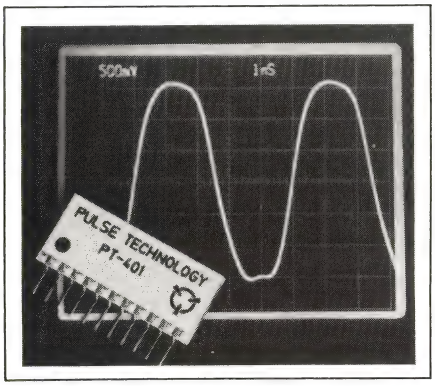

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- *Output frequency is 200 MHz*
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Pulse Instruments Co, 1234 Francisco St, Torrance, CA 90502. Phone (213) 515-5330.

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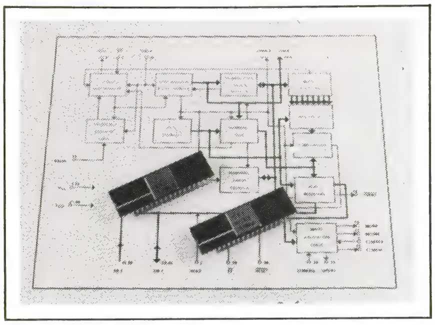

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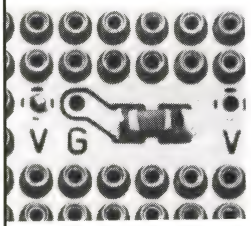

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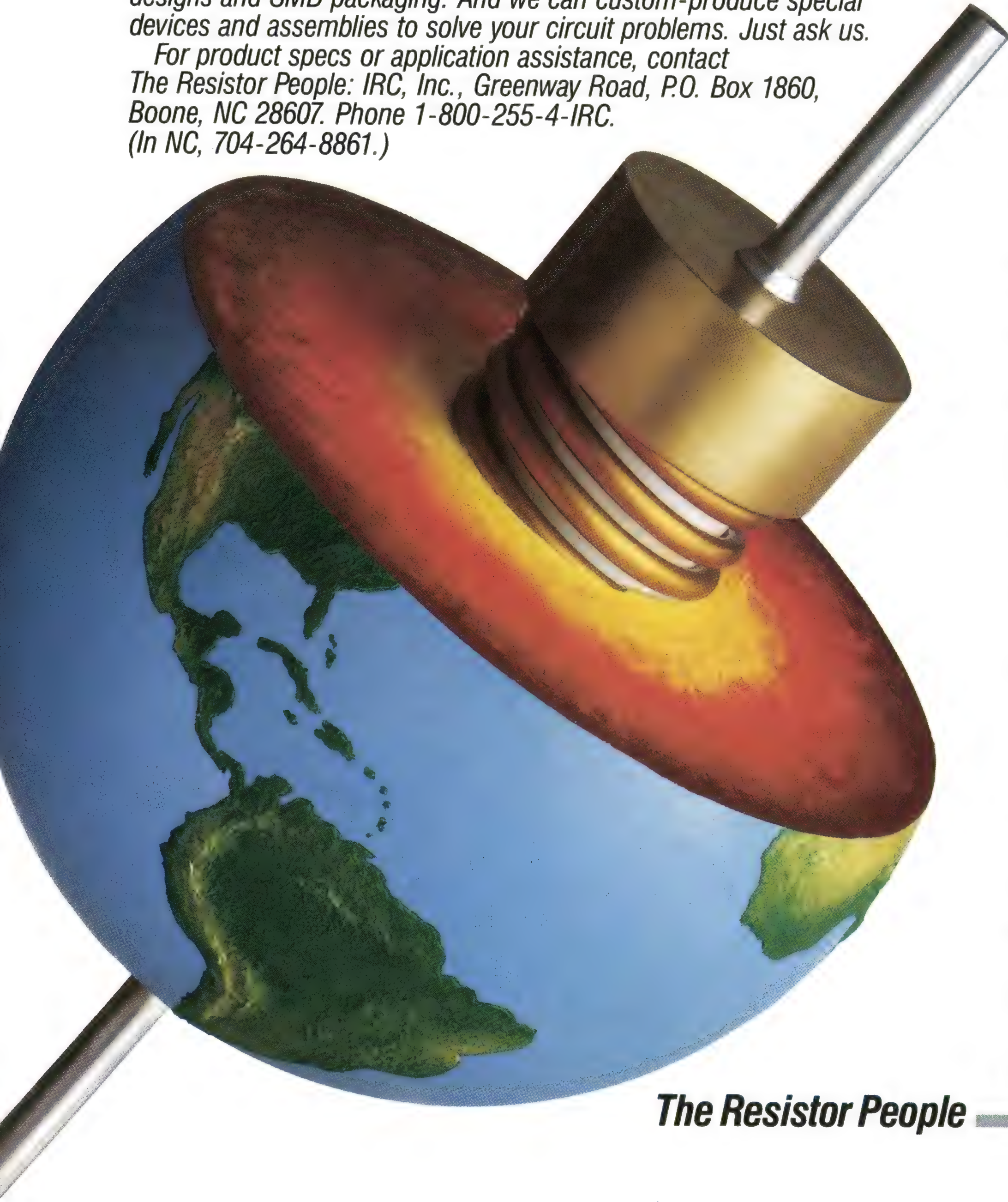

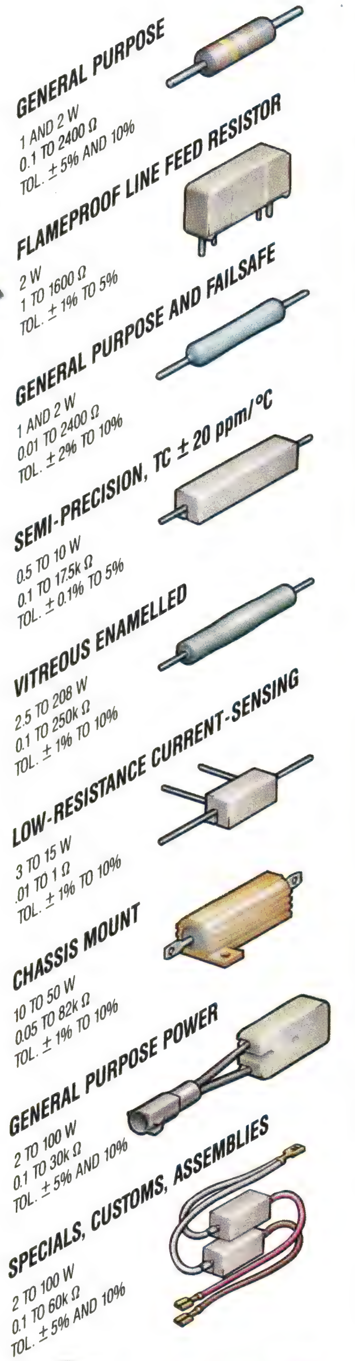

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Plessey Semiconductors Ltd, Cheney Manor, Swindon, Wiltshire SN2 2QW, UK. Phone (0793) 36251. TLX 449637.

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Plessey Semiconductors, 9 Parker, Irvine, CA 92718. Phone (714) 472-0303.

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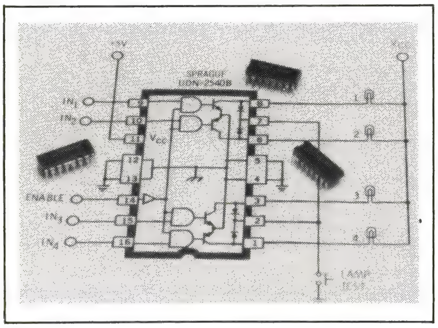

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- *60V/1.5A output capability with integral suppression diodes*
- *TTL, CMOS, PMOS, NMOS compatible*

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Sprague Electric Co, Box 9102, Mansfield, MA 02048. Phone (617) 853-5000.

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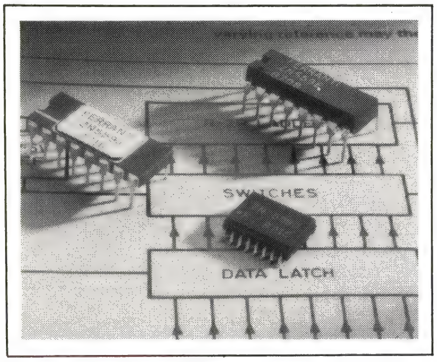
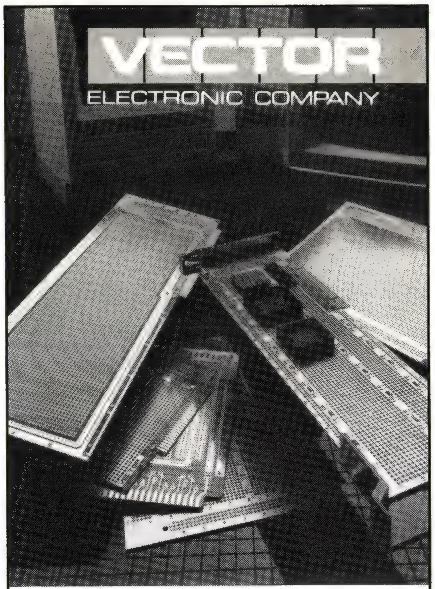


D/A CONVERTER

- *Has on-chip data latches*
- *Is monotonic over the full operating temperature range*

The ZN559 is a μP-compatible 8-bit D/A converter with an on-chip 2.5V bandgap reference. After a full-scale output change, the output settles to 0.5 LSB typically within 1.25 μsec. The typical settling time for a 1-LSB output change is 800 nsec. Maximum linearity error is ±1 LSB, and maximum differential nonlinearity is ±0.75 LSB, with monotonicity guaranteed over the full operating temperature range. The maximum zero offset is 6 mV, and full-scale output is typically 2.55V (2.54V minimum; 2.56V maximum) with a full-scale output temperature coefficient of 2 ppm/°C typ. On-chip latches with TTL/CMOS-compatible inputs allow you to load 8-bit parallel data into the device under the control of a latch-enable input. The ZN559 operates from one 5V supply and typically consumes 20 mA of supply current. It's available in a 16-pin DIP that operates over the commercial or military temperature range, or you can order it in a SO-16 surface-mount



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800/423-5659 Outside CA 125

CIRCLE NO 28

package that operates over the commercial temperature range. $2.98 (100) for commercial-temperature-range devices.

Ferranti Electronics Ltd, Fields New Rd, Chadderton, Oldham OL9 8NP, UK. Phone 061-624 0515. TLX 668038.

Circle No 371

Ferranti Electric Inc, 87 Modular Ave, Commack, NY 11725. Phone (516) 543-0200. TLX 6852104.

Circle No 372

PLL SYNTHESIZER

- *Operates in single- or dual-modulus modes*
- *Includes a voltage doubler for greater output dynamic range*

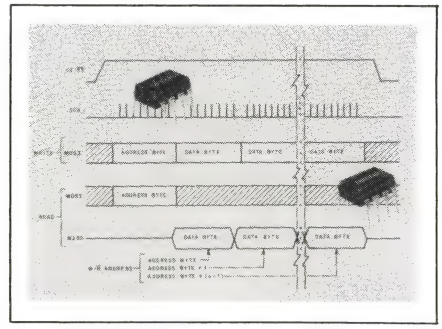
The TBB200 CMOS PLL frequency synthesizer is targeted for use in radio communications equipment—for example, 900-MHz cellular radios. The synthesizer incorporates two programmable dividers—one with a division ratio of between 1 and 127, and the other with a division ratio of between 3 and 4095—to divide down the VCO-frequency input. It also includes a reference-frequency divider with a division ratio of between 3 and 65,535. The two independent dividers for the VCO frequency and a single-line output that you can use to control the division ratio of an external prescaler allow you to operate the synthesizer in a dual-modulus mode. In single-modulus mode, the maximum frequency for the VCO-frequency input is 70 MHz; in dual-modulus mode, the figure is 30 MHz. The maximum frequency for the reference input is 30 MHz. The on-chip phase detector incorporates a voltage doubler to extend the dynamic range of its output, but you can disable the voltage doubler if required by omitting one external capacitor. The TBB200 operates from a 5V supply and comes in a 14-pin plastic DIP or a SO-14 surface-mount package. $3 (1000).

Siemens AG, Zentralstelle für Information, Postfach 103, 8000 Munich 1, West Germany. Phone (089) 2340. TLX 5210025.

Circle No 373

Siemens Components Inc, 2191 Laurelwood Rd, Santa Clara, CA 95054. Phone (408) 980-4500.

Circle No 374



STATIC RAMs

- *128-word×8-bit and 256-word×8-bit versions*
- *Standby current is 1 μA typ*

The CDP68HC68R1 (128-word×8-bit) and CDP68HC68R2 (256-word×8-bit) are CMOS, serial static RAMs that have separate data-input and 3-state-output pins. Each device is suitable for use in serial peripheral interface (SPI) systems based on the CDP6805, CDP68HC04, CDP1804A, or 80C51 microcomputer families. In such systems, the microcomputer generates a clock signal only during address and data transfers. Both chips operate from voltages spanning 3 to 5.5V; they will retain data when the supply voltage is as low as 2V. The typical standby current is 1 μA. The devices come in 8-pin DIPs. CDP68HC68R1E, $1.38; CDP68HC68R2E, $1.85 (1000).

GE Solid State, Rte 202, Somerville, NJ 08876. Phone (201) 685-6771.

INQUIRE DIRECT

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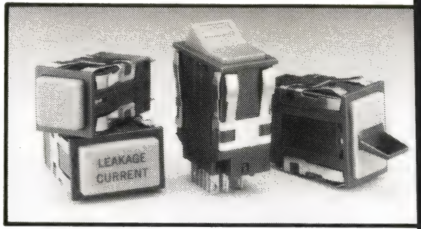


Solid state AML manual controls

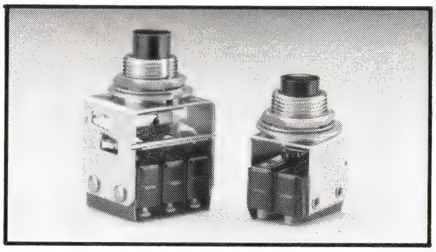
A Hall effect integrated circuit is the key to reliability and long life in these solid state pushbuttons, rockers, and paddles from the industry standard AML line. Simple to install and easy to wire, they can interface directly with microprocessors and other types of logic level circuitry.

These manual controls are designed with human factors in mind. For wide angle visibility, LED lighting is available. A variety of colors and legends offer additional design flexibility.

These products are UL and CSA recognized, and feature an 18-month warranty.

For more information or a FREE catalog covering our full line of manual controls, write MICRO SWITCH, Freeport, IL 61032. Or call 815-235-6600.

CIRCLE NO 235



Compact size, up to 4-poles

These tactile feedback and short travel pushbutton switches from the PB Series have a display area of just .32", making them ideal for tight spaces. Yet they can incorporate up to four SPDT circuits.

Touch feedback PBs use a spring loaded actuator. To reduce travel and operating force, the short travel version uses a leaf spring actuator. Momentary action is provided.

These switches feature round-hole mounting and handle up to 11 amps. Buttons are available in black, red, and green for design flexibility.

For more information or a FREE catalog covering our full line of manual controls, write MICRO SWITCH, Freeport, IL 61032. Or call 815-235-6600.

CIRCLE NO 29

Reducing your product costs could be as simple as pushing the right buttons.

How can a little thing like a MICRO SWITCH pushbutton lower the cost of making your product? Dozens of ways.

We can add, subtract, or redesign our standard pushbutton features to eliminate manufacturing steps. Reduce inventory requirements. Or lower component costs.

Sometimes it's as simple as leaving out features like audible feedback or UL listing when they're not needed.

Or it can get as involved as supplying a finished subassembly with custom-molded buttons, legended faceplate, keylock, PC board, and LEDs.

When it comes to saving you money without sacrificing product performance, we can be very flexible.

To learn more about how we can work with you to reduce total costs, or improve product performance or appearance, ask for our new brochure. Call us at 815-235-6600, ext. 610. Or write MICRO SWITCH, Freeport, IL 61032.

Together, we can find the answers.

MICRO SWITCH
a Honeywell Division

Stop by and Visit us at Booth #1951 during Electro, NY

CIRCLE NO 253

THE ONLY DIFFERENCE BETWEEN AN ITT SWISS RELAY AND AN ALCATEL SWISS RELAY IS THE NAME.

But you probably already knew that. ITT Swiss relays now have another name on the front. You can't miss it. The name Alcatel Swiss is in the same place where ITT Swiss was.

So, what's different? Not much. And definitely less than our competition would have liked.

Some details: Alcatel: Despite its youthfulness, this European association of enterprises has become quite well known.

Alcatel's goals have always been set quite high, a fact which is not really surprising when we consider the competition from America and Japan—not to mention that from the Far East.

So it must be clear that our competence in the manufacture of relays is a matter of great importance in this situation. We can offer a list of plus points which will continue to be available in the future, of course.

Indeed, these plus points are precisely those points necessary to meet the competition of today and tomorrow. Therefore they will be changed very little.

Our relay customers know what we mean. If you are not one of them, then this information will be even more important for you. Allow us to make a few points:

Dr. Juchli 777 STR

PZ Relay: a wonderful example of our pioneering in this field. This was the first relay which could be soldered directly into P.C. boards. This is the only series in the world with a choice of 2, 4 or 6 changeover contacts.

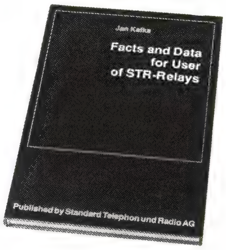
SM Relay: Another typical pioneering effort of our relay laboratories featuring extremely flat profile and an extremely quiet operation. Completely plastic coated, this unit exhibits (in contrast to the competition) exceptionally good anti-shock and anti-vibration characteristics as well as resistance to tropical and wet conditions.

MT Relay: a monostable relay that has no peers. Non-polarized. Suitable for very high packing density. Compatible. Never needs readjustment. A guaranteed 10 million changeovers under dry conditions. Functionally guaranteed within a temperature range of −55 to +70 degrees centigrade. Failure ratio guaranteed to be under 0,5% over the lifetime of the relay. Can be supplied for coil voltages up to 48 V and 150 mW capacity!

We are sure you will agree that is an impressive list of relay plus points.

Now it should be clear just why, except for the name, it is the same old range of products. After all, they are still the latest state of the art.

Everything you have always wanted to know about relays but didn't know where to find the information, has been compiled in the new STR Relay Handbook. A competently written indispensable practical aid for everyone who wants to be on top of everything in the world of relays. We would be happy to send you one—free of charge, of course.


Jan Kafka
Facts and Data for User of STR-Relays
Published by Standard Telephon und Radio AG

Company

Address

Responsible Party

Standard Telephon und Radio AG, CH-8055 Zurich
Friesenbergstrasse 75, Switzerland EDN

ALCATEL
STR

CIRCLE NO 254

OPTICAL MODULES

- *Designed for high-speed digital applications*
- *Possess 1.3-μm operating wavelength*

These fiber-optic transmitter and receiver modules operate at 1.3 μm and are designed for high-speed digital applications. The 1218-Type transmitter operates at data rates to 1G bps and incorporates an InGaAsP laser, a thermoelectric cooler, a monitoring photodiode, modulation circuitry, and feedback controls. It operates on 5V and is housed in a 14-pin hermetic SIP (single in-line package). The 1306AA linear receiver can accommodate 1.7G-bps data rates. It employs an avalanche-photodiode detector and a GaAs IC preamplifier with adjustable transimpedance. The preamp's typical −32-dBm sensitivity can be achieved at 3×10^{-11} bit-error rates. 1218-Type, $2500 to $4500; 1306AA, $2850 (100).

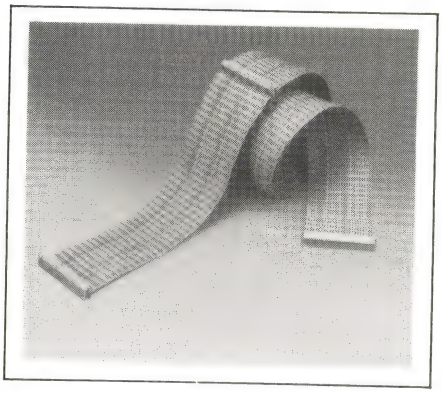
AT&T Components and Electronic Systems, Dept 50AL203130, 555 Union Blvd, Allentown, PA 18103. Phone (800) 372-2447.

Circle No 394

FLAT CABLE

- *Eliminates the flat spots usually provided for termination*
- *Available with 16 to 64 conductors*

Space-Mizer IDC-compatible woven-design cables eliminate the flat spots customarily provided for termination. The conductors feature 50-mil spacings, so you can terminate the cables at any point. The cables come on standard bulk reels, and you can order them in increments of 100 ft (300 ft max) and with 16, 20, 26, 34, 40, 50, 60, or 64 color-coded and individually insulated conductors. The cables meet the requirements of UL Style 20503; CSA (Canadian Standards Association) approval is pending. $74.36 for a 100-ft 26-conductor cable.



Woven Electronics, Box 667850, Charlotte, NC 28266. Phone (803) 963-5131.

Circle No 395

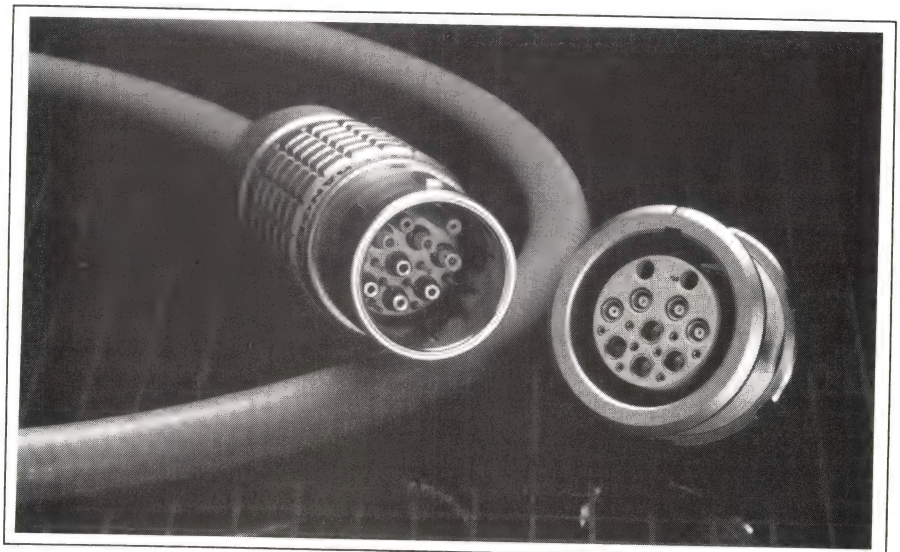
RELAY

- *100,000-cycle lifetime*
- *1500V ac dielectric strength*

Available in 1A, 1B, 1C and 1CW configurations, the Oar relay has a 30A switching capability and a dielectric strength of 1500V ac between coil and contacts. Designed for pc-board mounting, the relay has a control-voltage range of 5 to 24V dc. Its shock resistance measures 10g min. The relay has a 100,000-cycle electrical lifetime, and the operating range spans −55 to +85°C. $1.09 (1000). Delivery, eight to 12 weeks ARO.

Original Electric Mfg Co Inc, 123B Lincoln Blvd, Middlesex, NJ 08846. Phone (201) 271-5770.

Circle No 396



CONNECTORS

- *Combine fluidic or pneumatic contacts and signal contacts*
- *Guaranteed for 5000 mating cycles*

Designed for industrial ink-jet printer applications, these mixed-contact connectors combine in a single housing four 50Ω coaxial contacts, two 5-kV contacts, eight signal contacts, and four fluidic or pneumatic contacts. The devices are guaranteed to last 5000 mating cycles min. They accept cables to 1 in. in diameter and have a 180-lb cable-retention spec. They feature a quick-connect or -disconnect self-latching system. $266.24 per pair (500 pairs).

Lemo USA Inc, Box 11488, Santa Rosa, CA 95406. Phone (707) 578-8811. TLX 340933.

Circle No 397

Continued on pg 282

THE ANSWER IS IN TEK DIGITAL STORAGE:

$2995
$3995
$4995

Now! The new 60 MHz Tek 2221 joins the world's best-selling family of digital storage oscilloscopes. All featuring 20 MS/s *digitizing* along with familiar, full-bandwidth analog operation. It's the best of both worlds in an easy-to-use portable.

Discover the potential. With digital storage you can freeze waveforms. Capture events invisible to nonstorage scopes. Find signals buried in noise. And build a library of reference waveforms.

Digital storage display accuracy enhances your confidence in measurements. And all you have to do is push a button for *real-time* display analysis.

Compare the 2230, 2221 and 2220 to each other—and all others. The new 2221 offers such advanced features as CRT readout and measurement cursors. For even more performance and flexibility, there's the 100 MHz, dual time base 2230 with optional battery-backed memory for saving up to 26 waveform sets. And if it's economy you want, choose the 60 MHz 2220 with many of the same features at an even lower cost.

Features	2230	● NEW! 2221	2220
Analog/Digital Storage BW	100 MHz	60 MHz	60 MHz
Maximum Sampling Speed	20 MS/s	20 MS/s	20 MS/s
Record Length	4K/1K (selectable)	4K	4K
Peak Detect	100 ns	100 ns	100 ns
Save Reference Memory	One, 4K Three, 1K	One, 4K	One, 4K
Vertical Resolution	8 bits 10 bits (AVG mode) 12 bits (AVG mode over the bus)	8 bits 10 bits (AVG mode)	8 bits
CRT Readout/Cursors	Yes	Yes	No
GPIB/RS-232-C Options	Yes ($750)	Yes ($500)	Yes ($500)
Battery-Backed Memory (save 26 waveform sets)	Yes (inc with GPIB/ RS-232-C)	No	No
Price	$4995	$3995	$2995

With each scope you can capture events as narrow as 100 ns at any sweep speed thanks to Tek's proprietary peak detect mode. View events prior to or following a trigger event with pre/post trigger. Store waveforms into 4K records. Automate measurements with optional GPIB and RS-232-C interfaces. And output direct to a printer or plotter.

Tek software is available to help you make the most of the 2230, 2221 and 2220 in system configurations.

Call Tek for a free video brochure or to place an order.

Ask about free digital storage application notes and educational materials. Orders include complete documentation, manuals and 3-year warranty on labor, parts and CRT.

Call Tek direct:
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for free video brochure
for orders/assistance.

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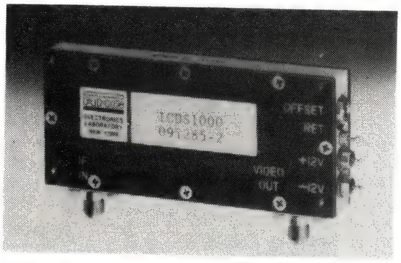
CIRCLE NO 189



IF LIMITER

- *Features 5-nsec rise time*
- *500-MHz bandwidth*

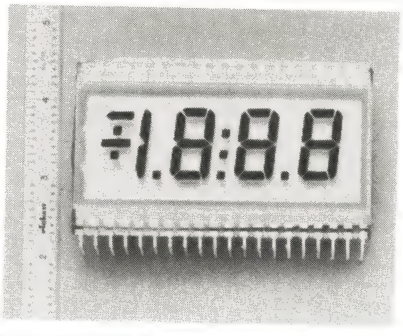
The Model ICDS1000 IF limiter/discriminator operates at 1000 MHz with a p-p bandwidth of 500 MHz and a linear bandwidth of 300 MHz min. Specially designed video amplifiers provide a 5-nsec rise time. The unit is rated for an input level of 0 dBm, but it is usable to −10 dBm. The video output measures 10 mV/MHz min. Designed for MIL-E-5400 and MIL-E-16400 environments, the ICDS1000 operates over a −54 to +71°C range. The frequency accuracy is 10% over the full operating range and better than 5% at 25°C. Standard models operate from ±12V supplies, but units that operate from 15V are available. $1995. Delivery, 90 days ARO.

RHG Electronics Laboratory Inc, 161 E Industry Ct, Deer Park, NY 11729. Phone (516) 242-1100.

Circle No 398

DISPLAY

- *Features 1-in. characters*
- *Readable from 20 ft*



The LCD 5618 is a direct-drive, 40-pin, 3½-digit display with a character height of 1 in. The 7-segment unit has a viewing distance of 20 ft and is offered in two versions. The economy model has a −10 to +60°C operating range; the high-performance version operates over −40 to +84°C. Options include reflective or transflective polarizers and a choice of fixed dual-in-line pins or elastomeric-type terminations. The liquid-crystal material is environmentally tested for stability, and the package is epoxy sealed to ensure an operating life of more than 5 years. Standard economy model with reflective polarizers and fixed-pin terminations, $17.10 (100). Delivery, stock to six weeks ARO.

IEE Inc, Component Products Div, 7740 Lemona Ave, Van Nuys, CA 91409. Phone (818) 787-0311. TLX 4720556.

Circle No 399

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We supply a wide range of products to boost your sales in 1987, including PS/II signal cable Round Cable & Flat Cable Assemblies, D-Subconnectors, 57 Series Connectors, Modular Jacks, Gender Changers, Switching Power Supplies, Pin Headers, Terminal Strips, etc. Contact us right away for further information.

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CIRCLE NO 31

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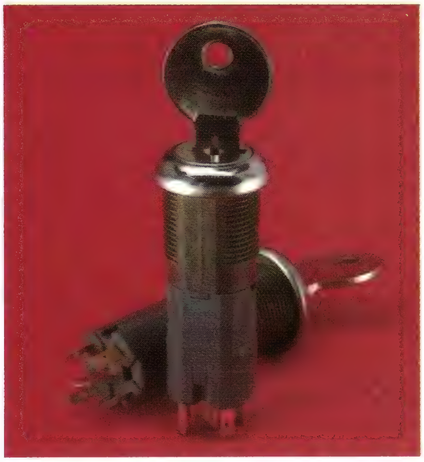

Anti-Static Keylock Switches For All Ratings To 4 Amps @ 120 V.A.C.

Oak anti-static keylock switches protect sensitive electronic circuitry from inadvertent static discharges of up to 20 KV. They can be used for operating voltages from dry circuits to 4 amps at 120 V.A.C. These switches also provide equipment security from unauthorized users. Market applications include CRT terminals, point-of-sale terminals, credit verifications systems, bank teller systems and security systems.

Only 2-1/2 inches long, the Oak anti-static keylock switch will fit a .760 diameter x .635 double flatted cutout. Oak anti-static keylock switches are UL and CSA listed and are available in a wide range of key options.

Contact: Oak Switch Systems Inc.
P.O. Box 517
Crystal Lake, IL 60014
Phone: 815/459-5000

CIRCLE NO 190

Low-Profile, Full Travel Membrane Based Keyboards

Oak's Low-Profile FTM uses an optomized keymodule that provides improved consistency, better feel and lower cost per keystroke position. DIN compatible, Oak FTM keyboards are designed for high speed data entry systems that require long life and operator comfort.

The patented switch design has a profile of just 19.9 mm (0.785 inches). Operating (finger) forces of the keystroke are available from .9 to 6 ounces. The keyswitch features only four parts providing extremely high reliability – in excess of 50 million cycles.

Contact: Oak Switch Systems Inc.
P.O. Box 517
Crystal Lake, IL 60014
Phone: 815/459-5000

CIRCLE NO 191

Off-The-Shelf Rocker Switches To Fit Your Design Parameters

Oak rocker switches are available in an assortment of designs, colors, sizes and styles to retrofit most existing design parameters. Choose from 6 standard colors and 9 profiles in single or double pole, lighted, non-lighted, or LED varieties.

Oak rocker switches are UL and CSA approved. Most have VDE, BEAB and SECV approval.

Contact: Oak Switch Systems Inc.
P.O. Box 517
Crystal Lake, IL 60014
Phone: 815/459-5000

CIRCLE NO 192

These keyboards may look the same. . . but there are some

key differences.

OAK keyboards give you

- Choice of eight standard keyboard layouts
- The ability to modify key legends and case colors
- Fast delivery and superior quality

The first key difference is flexibility. Start with any of eight popular keyboard styles. Then, for a nominal cost, you can change key legends and case colors to design a keyboard that meets your individual requirements – our second key difference.

The third is OAK's ability to deliver standard or modified boards quickly – often between 4-6 weeks.

OAK combines quality and reliability to give you the performance you demand – all at highly competitive pricing. If necessary, OAK can also provide completely custom keyboard designs.

For more information about the differences of OAK keyboards **call 815/459-5000 today!**

OAK keyboards are available in these eight standard styles with your choice of linear or tactile feel.

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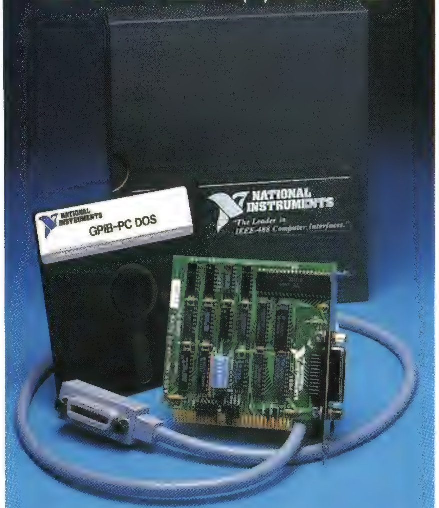
KB097-PC
KB101-PC/AT
KB102-PC/AT
KB121-PC
KB3270-PC
KB090-MAK/PC
KB105-220

OAK Switch Systems Inc.
P.O. Box 517
Crystal Lake, IL
Phone: 815/459-5000



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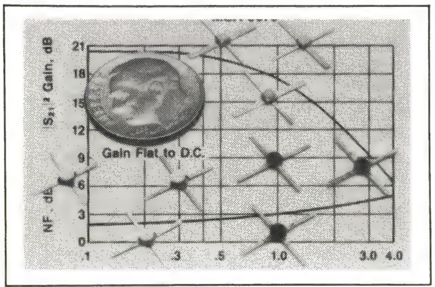


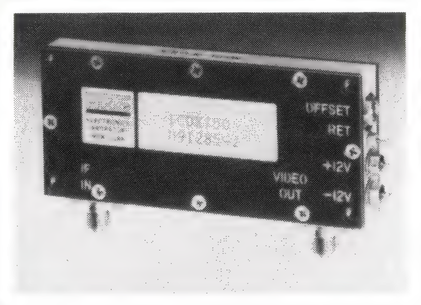
AMPLIFIERS

- *Operate on 5V supplies*
- *Have gains to 19 dB typ*

Offering a dc to 4-GHz frequency range, these general-purpose monolithic microwave IC amplifiers are cascadable 50Ω gain blocks that can operate with power supply voltages as low as 5V. At 0.5 GHz, the MSA-0635 and MSA-0670 typically feature a 19-dB gain and a 2.8-dB noise figure. The MSA-0685 features an 18.5-dB gain and a 3-dB noise figure. The MSA-0635 is housed in a glass-sealed microstrip ceramic package. The MSA-0670 is in a 70-mil hermetically sealed metal ceramic package and the MSA-0685 comes in an 85-mil plastic package. MSA-0635, $5.40; MSA-0670, $18.90; MSA-0685, $2.30 (100).

Avantek Inc, 3175 Bowers Ave, Santa Clara, CA 95054. Phone (408) 970-2659.

Circle No 400



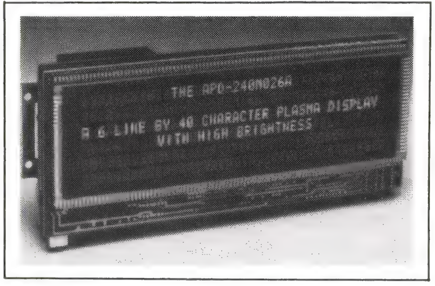
IF LIMITER

- *Operates at 750 MHz*
- *Rated for 0-dBm input level*

The ICDX750 IF limiter discriminator operates at 750 MHz and has a peak-to-peak bandwidth of 450 MHz. Its linear bandwidth equals 250 MHz min. The unit has a 20-nsec rise time and is rated for a 0-dBm input level, but it's usable down to −10 dBm. The ICDX employs a delay line for demodulation coupled with a constant-phase limiter/driver for minimum degradation of pulsed waveforms. It is designed for MIL-E-5400 and MIL-E-16400 environments and has a −54 to +71°C operating range. The standard model operates at ±12V; a unit is available for 15V operation at no extra charge. $1535. Delivery, 90 days ARO.

RHG Electronics Laboratory Inc, 161 E Industry Ct, Deer Park, NY 11729. Phone (516) 242-1100. TWX 510-227-6083.

Circle No 401



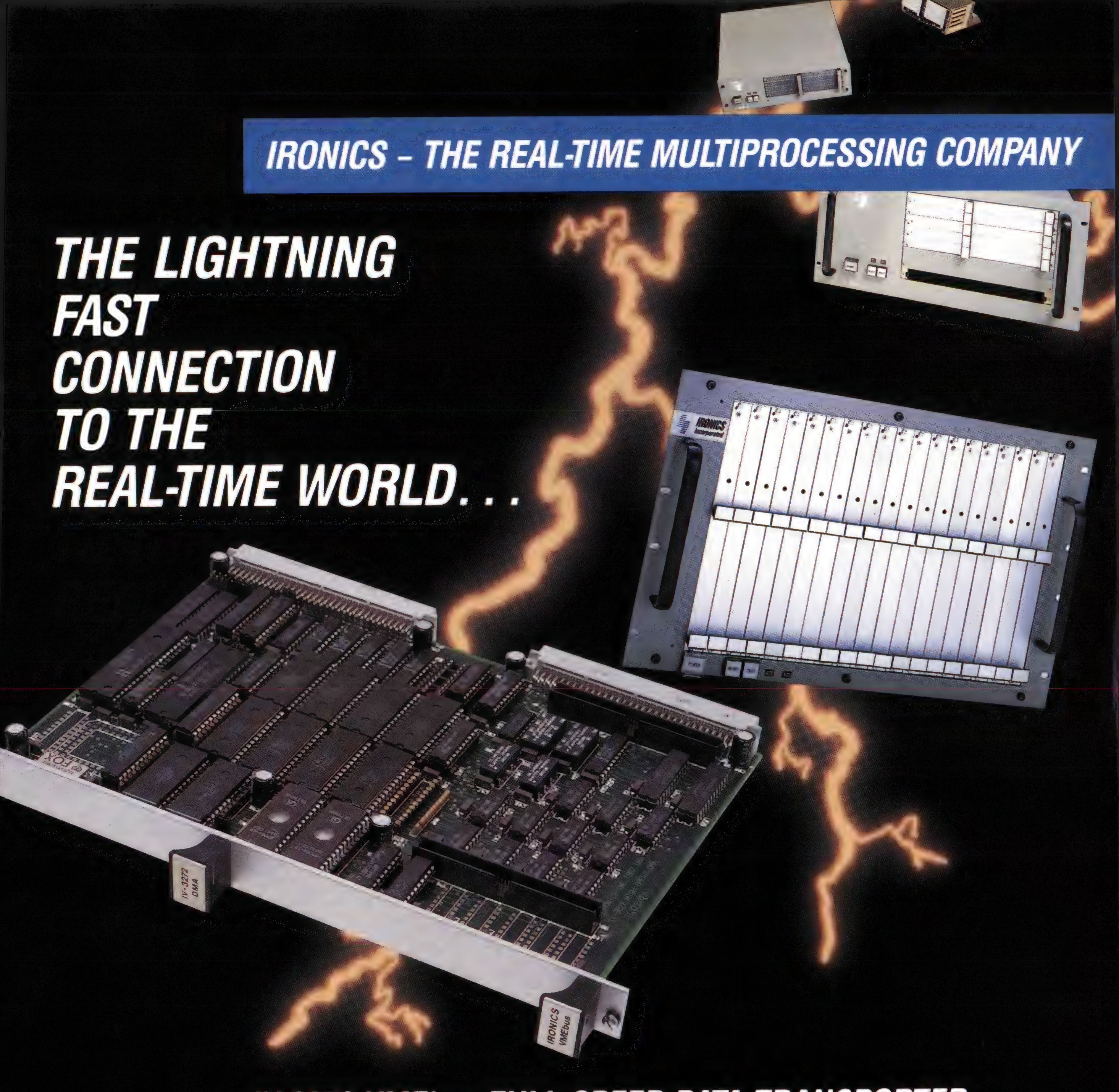
PLASMA DISPLAY

- *Includes drive electronics*
- *Interfaces with CRT controller*

The APD-240MO26A 240-character dot-matrix plasma panel display comes with drive electronics. It displays six lines of 40 characters and provides information in a row-by-row scanning mode that begins at the top. Each of the 5×7 dot-matrix characters has a height of 0.26 in., and the panel's viewing area measures 2.26×8.33 in. The unit specs a 100-fL brightness level and a 150° viewing angle, and you can easily interface it with CRT controllers. You can also order a model with a controller board that has parallel and RS-232C ASCII inputs. $480 (100). Delivery, six to eight weeks ARO.

Dale Electronics Inc, 2064 12th Ave, Columbus, NE 68601. Phone (402) 564-3131.

Circle No 402



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  32.8 Mbytes/sec (writes) dual-port transfer rate achievable using Ironics' Multiprocessing Engines™
- ***PROCESS DATA 'ON THE FLY' WITH ON-BOARD DIGITAL SIGNAL PROCESSOR***
  TI 32010,020 or C-25 DSP Chip is user-programmable

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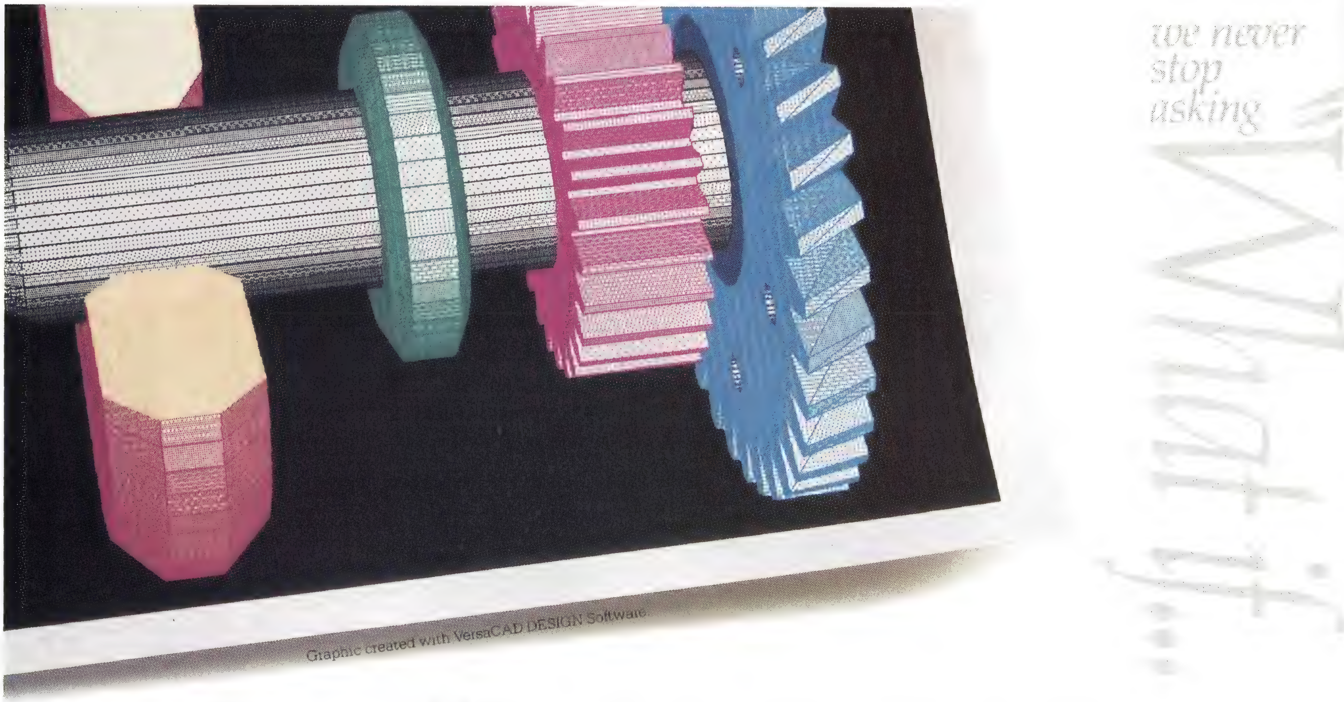
CIRCLE NO 193

IRONICS Incorporated



The new HP PaintJet color graphics printer.
Great color is only ½ the story.

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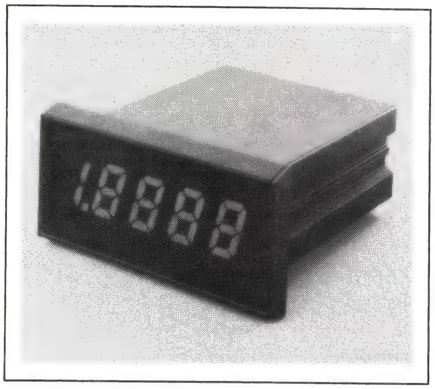
COMPONENTS & POWER SUPPLIES



AUTORANGING DPM

- *Features ±0.01% accuracy*
- *Supports RS-232C or RS-422 interfaces*

The DP-950 μP-controlled 4½-digit device can operate in either the autoranging mode or as a fixed-input digital panel meter (DPM). It has input ranges of ±2, ±20, ±200, and ±1000V dc, and it features over- or underrange indication and RS-232C or RS-422 serial support. Its accuracy equals ±0.01%±1 count, and its overvoltage protection measures 1200V min. The DPM operates on either 115 or 230V ac. It provides 5 and −5V output to power external circuitry. Its red LED display has 0.56-in.-high characters. You can select continuous-data-streaming or return-on-request modes, and make power and signal connections through a 30-pin edge connector or an optional termination block. $375.

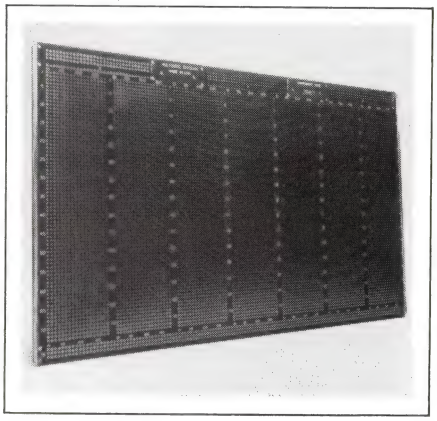
Acculex, 440 Myles Standish Blvd, Taunton, MA 02780. Phone (617) 880-3660. TLX 240713.

Circle No 403

PROTOTYPE BOARDS

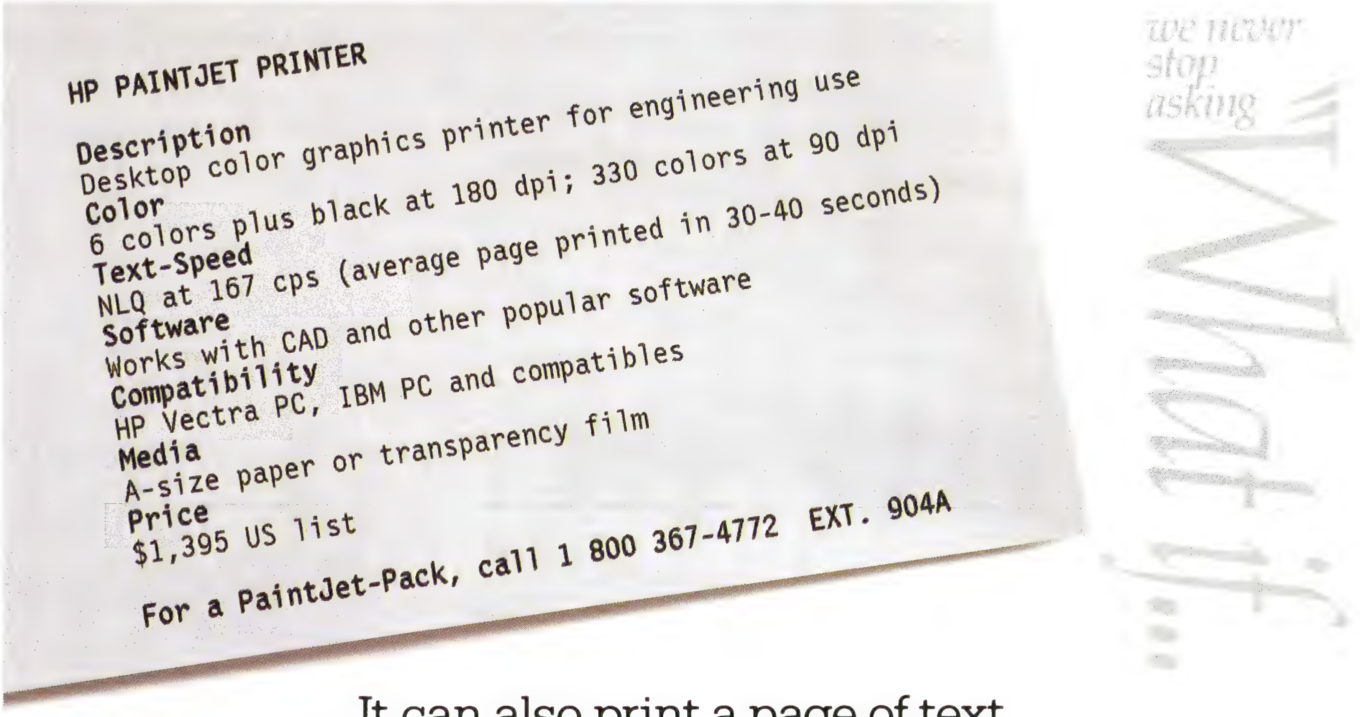
- *100% electrically tested*
- *Single-slot mountable*

Protoboard Series prototype boards offer designers an alternative to wire-wrappable panels. Each board has been 100% electrically tested on a bed-of-nails tester and features a 0.1-in. hole pattern that accommodates different package types. Single-slot mountable, the boards maximize utilization of card rack space. The series includes four Mupac-compatible boards and one Multibus-compatible board. $485 to $1700.



Multiwire/East, 250 Miller Pl, Hicksville, NY 11801. Phone (516) 933-8300.

Circle No 404


we never
stop
asking
What if...

HP PAINTJET PRINTER

Description
Desktop color graphics printer for engineering use
Color
6 colors plus black at 180 dpi; 330 colors at 90 dpi
Text-Speed
NLQ at 167 cps (average page printed in 30-40 seconds)
Software
Works with CAD and other popular software
Compatibility
HP Vectra PC, IBM PC and compatibles
Media
A-size paper or transparency film
Price
$1,395 US list

For a PaintJet-Pack, call 1 800 367-4772 EXT. 904A

It can also print a page of text
in 30 seconds flat.

HEWLETT
PACKARD
CIRCLE NO 33

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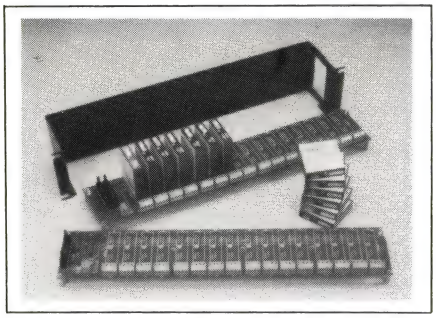
COMPONENTS & POWER SUPPLIES



SIGNAL CONDITIONERS

- *Feature 1500V isolation*
- *±0.05% accuracy*

The MB Series hard-potted signal-conditioning modules accept raw analog input and provide a 0 to 5V or ±5V output. The modules feature 1500V transformer-based isolation and accept thermocouple, RTD, current, low- or high-level voltage, and wide bandwidth (to 10 kHz) inputs. They have ±0.05% accuracy. You can plug as many as 16 modules into either the MB-01 or MB-02 mounting backplane. All modules are the same size and have the same pin connections. Modules, $150; MB-01, $250; MB-02, $260.

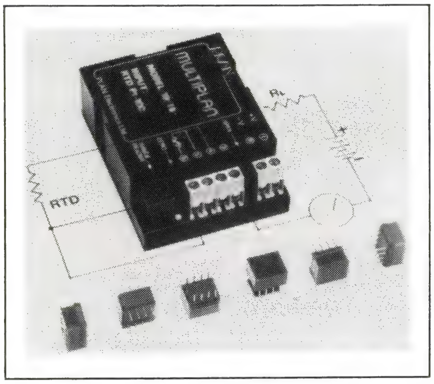
MetraByte Corp, 440 Myles Standish Blvd, Taunton, MA 02780. Phone (617) 880-3000. TLX 503989.

Circle No 405

4- to 20-mA TRANSMITTER

- *Versions available for a range of sensor types*
- *Feature programmable input sensitivities*

This range of sensor transmitters has an output of 4 to 20 mA and features small plug-in header modules that adapt the transmitters for a range of input sensitivities. The line includes a standard model for each type of sensor, including models for platinum resistance thermometers, thermocouples, dc voltage or current sources, and potentiometric transducers. By changing the header module in each transmitter, you can alter the input range of each type of transmitter. Transmitters are supplied with one header module, but you can change the module for a different type if required. They are supplied with a universal mounting kit that also adapts to DIN-rail mounting systems. Approximately £100 (100).



TC Ltd, Box 130, Uxbridge UB8 2YS, UK. Phone (0895) 52222. TLX 264820.

Circle No 406

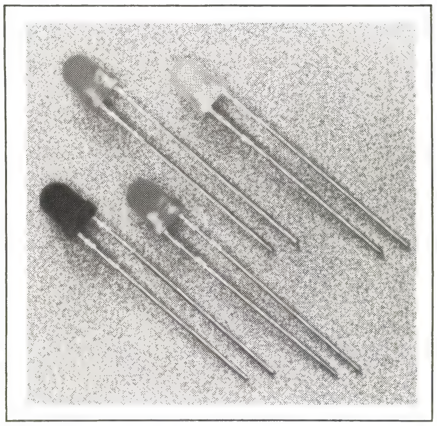
RELAYS

- *Eliminate arcing at contact points*
- *Have contact rating of 30A at 50V dc*

These high-current relays eliminate contact-point arcing and thus extend their expected life to 1 million operations min. They also meet the vibration and shock specifications of MIL-R-6106, characteristic C. The contacts possess a 30A at 50V dc rating for resistive loads and a 17A at 50V dc rating for motor loads. The coil's pickup sensitivity equals 500 mW. The relays meet EMI MIL-STD-461B.REO2 for RFI. They are available in 1 Form A configurations. $290 (100). Delivery, 22 weeks ARO.

Electronic Specialty Corp, Box 3501, Vancouver, WA 98668. Phone (206) 574-5000.

Circle No 407



LED LAMPS

- *Have 10-mcd luminous intensity*
- *Come in four colors*

SLR-40 Series T-1⅜ LEDs have a 50° viewing angle and a luminous intensity of 3.6 mcd min and 10 mcd typ. Forward current is 2V typ at 10 mA, and reverse current equals 10 μA at V_R=3V. They operate over −55 to +100°C. The devices are packaged for brightness matching, and you can order them in one of four colors—orange, red, yellow, or green. They come in an ammo pack or on a customer-specified taping on reel. $0.15 to $0.25 (1000), depending on color. Delivery, stock to eight weeks ARO.

Rohm Corp, Box 19515, Irvine, CA 92718. Phone (714) 855-2131. TWX 910-595-1721.

Circle No 408

NDK 1300 Series Compact Crystal Clock Oscillators

NDK's 1300 Series offers the widest range of CMOS- and TTL-compatible compact oscillators available. Frequencies from 28 kHz to 70 MHz with enable/disable std and dual-frequency output as an option. All in rugged, space-saving, half-size packages that are perfect for high density pc-board applications.

NDK 1300 Series Features

- Broadest range of available frequencies—28 kHz to 70 MHz
- Low-power/low-heat CMOS technology
- Choice of TTL, CMOS or dual-compatibility
- Compact size (0.52-inch square)—perfect for portables
- Quick rise and fall times (5, 7, 10 ns)
- Excellent fan out (2 or 5 TTL gates)
- Sealed, grounded metal case resists EMI, high temperatures, humidity
- Shock and vibration resistant

NDK: Your single source.

NDK offers the widest range of compact crystal oscillators, microprocessor quartz crystals, and standard crystal oscillators available. All fully guaranteed to be free from impurities and defects. And all readily available through NDK's nationwide network of stocking distributors.

For a free product catalog, or to order evaluation samples, contact NDK today.

NDK America, Inc.
20300 Stevens Creek Blvd., Suite 400
Cupertino, CA 95014-2210
Telephone: (408) 255-0831
Telex: 352057 NDKCOLTD CPTO
Fax: (408) 725-0369

NDK®

CIRCLE NO 34

He Just Spent $175,000 NEEDLESSLY On A Competitive PCB CAD Software System

You Can't Make Those Kinds of Mistakes and Survive in Today's Competitive World...

...especially when he could have owned Bishop's PATHFINDER™ PCB CAD system from anywhere from $1,995 to $7,990. And he would have had, on an IBM PC-based computer, the same schematic capture, layout and autorouting capabilities as the "mainframe-based" software system he bought.

If you've been designing printed circuit boards or doing hand tape-ups during the last 22 years, then you know Bishop Graphics as the world leader in printed circuit design and engineering products. An interesting thing happens when you are effectively the only company selling PCB design products in over 72 countries in the world. You see, there is absolutely no company anywhere in the world that has the existing customer base that Bishop has. As a result, just about every CAD company or author has approached Bishop to either privately label *their* CAD package or distribute it for them.

Now why is that important to you, the engineer, designer or drafter? Simple! We've waited a long time to decide *which* CAD package we wanted to put our name on. We've looked at the advantages and disadvantages of the packages that have been brought to us and we've looked very hard at where the industry is going. The more we looked and compared, the more we realized that PATHFINDER was *the* way to go.

WHAT MAKES PATHFINDER DIFFERENT?

We know that the majority of the serious designers would like a fully integrated CAD system with an autorouter that can lay down as many as three traces between a DIP if they want. The problem is not a heck of a lot of people can afford to spend $80,000 to $200,000 for a CAD package. **It didn't take us long to realize that PATHFINDER's AutoRouter had the power and performance of the most expense mainframe-based PCB CAD systems.** Nothing that we had evaluated, or that was brought to us (including most of the brand names that you know), could compare with the overall ability of PATHFINDER.

We've sold PCB design products to you for over 20 years and there's one thing that we know for certain...you're not interested in sales hype or fluff. **The problem that we're faced with, is how to convince you that it is foolish to spend $1,000 on a "make do" CAD system and just as foolish to spend $15,000, $20,000, or even $80,000 on a medium to high-end CAD system when you can get the performance of a $90,000 plus CAD system *at PATHFINDER's prices.***

LET'S TALK FACTS AND SPECIFICATIONS

PATHFINDER works in conjunction with, and uses the industry standard for 2D drafting... AutoCAD™ You get a complete PCB and electro-mechanical 2D CAE workstation. You have full schematic drawing and capture, layout plus 32-bit autorouting. Not only can you create your own netlists, partslists, etc. but you can take an ASCII formatted list or document from another CAD system and format it so that PATHFINDER will read it. You've also got full IGES and Gerber I/O capability. PATHFINDER even allows you to "preview" your photoplot *before* sending it out to be plotted. You have generation of silkscreen and solder mask layers, drill drawings, assembly drawings, fabrication drawings, fast "on-the-fly" parts creation, 3D views, color or monochrome at any resolution, hardware pan and zoom, the use of a TTL, discrete and connector part library, stretching the layout, the latest concept of "what you see is what you get" (WYSIWYG), ratsnesting, drag and rubber-banding, semi-automatic heat sinks, keepout areas, top and bottom views for SMT with 3D views, and on and on.

MAINFRAME PERFORMANCE AUTOROUTING

The power and speed of a true 32-bit autorouter is what PATHFINDER's AutoRouter is all about. We supply you, along with the AutoRouting software, a parallel processor card that allows you to autoroute using 32-bit integer manipulations. We don't play any games when we talk about true 45° routing. You get it with PATHFINDER. None of this 90° routing and then go back and chamfer the corners to make it look like a 45° route was actually done. We know, and you know, that buys you absolutely no additional "real estate" on the board.

PATHFINDER also provides you with *real time Display While Routing.* What good does it do to come back *after* the autorouting has taken place only to discover that you wish you would have stopped it 5 minutes into the routing design to make a manual edit? Also, you'll be able to autoroute down to 6¼ mil trace widths...3 traces between a DIP pad.

Another thing we discovered is that even mediocre autorouters can achieve 100% completion rates if the parameters are sloppy enough. The real test of autorouting is not just speed, not just percent completion, but most importantly the *quality of design.* **You'll achieve the same kind of performance and completion rates that you would achieve on mainframe-based autorouters with PATHFINDER.** You can autoroute up to 16 layers. You have total access to the strategy parameters given you in the AutoRouter including rip-up and re-route when needed.

FREE TECHNICAL HOT-LINE SUPPORT

Whether you're doing analog, digital or SMT work, PATHFINDER allows you the ability to get the job done. It's easy to use and comes with a thorough, complete technical manual and tutorial. It is a fully integrated, intuitive CAD system expressed in terms that the PCB engineer, designer or drafter can appreciate. Bishop will provide free technical hot-line support during your first year of use.

NO-RISK GUARANTEE

We are so thoroughly convinced that PATHFINDER will become the de facto standard in the industry that we'll let you use it for 30 days and if it doesn't meet our published specifications, we'll refund your money with no questions asked. We suggest that you take a minute now to call our toll-free number, 800-222-5808,* to get any of your questions answered that haven't, and can't, be answered in an ad. If you'd like to drop us a line, certainly do so, and mark your envelope "PATHFINDER."

**In Alaska, California, and Hawaii call (818) 991-2600.*

AVAILABLE NOW!

PATHFINDER	PATHFINDER
Schematic Capture & Layout	"Standard" AutoRouter
$1,995.00 (order #40000)	**$2,995.00** (order #40020)

The Innovators
Bishop Graphics
CAD Systems Corporation
5388 Sterling Center Drive
Westlake Village, CA 91359
Phone (818) 991-2600
Telex 66-2400 (BISHOP WKVG)
Facsimile (FAX) 1(818) 889-3744

CIRCLE NO 194

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Macintosh is a trademark of Apple Computer, Inc.

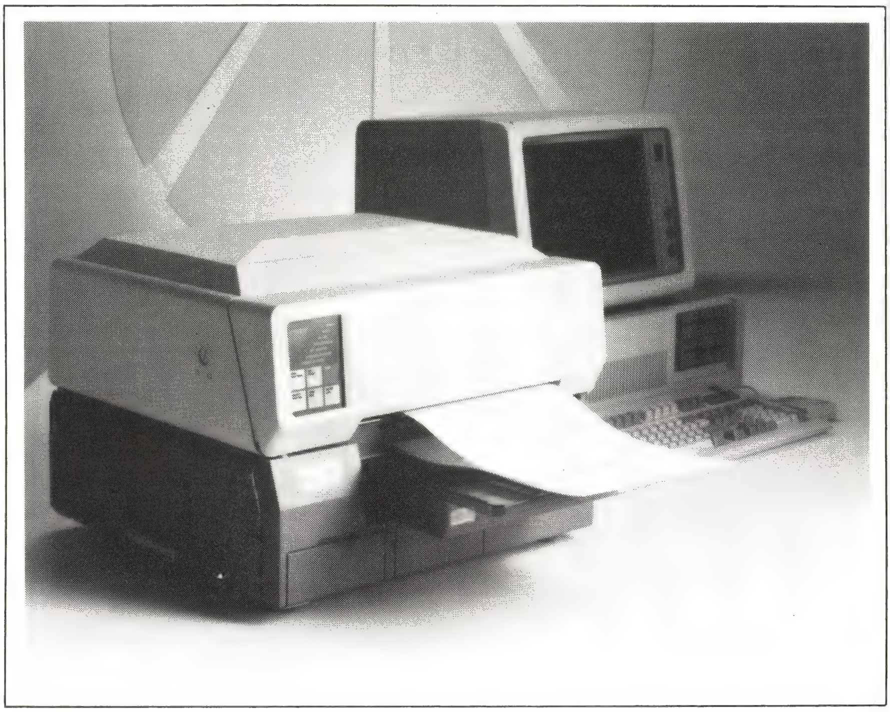
See us at WESCON, Booths 2638-2640, Moscony Center

NEW PRODUCTS

COMPUTERS & PERIPHERALS

PAGE PRINTER

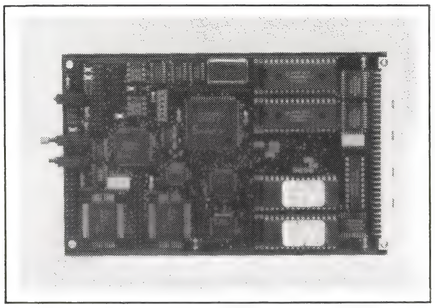
- *Has a resolution of 300 dots/in.*
- *Drum set and 5000-pg toner set are separate units*



The CrystalPrint VIII is a page printer that incorporates liquid-crystal shutter (LCS) technology. A light source shines onto an LCS array whose elements are either opened or closed. The selected light passage is sent through a nonrotating lens onto the drum. This technique yields a print resolution of 300 dots/in. and provides the reliability of nonmoving parts. The drum set and the 5000-pg toner set are also separate units, allowing individual replacement. The unit features full emulation of HP's LaserJet Plus and is compatible with Microsoft's Windows and Aldus's PC Pagemaker. It also has three ROM-resident and cartridge-based type fonts from Bitstream; downloadable fonts, including HP's compatible fonts; 1.5M bytes of RAM for bit-mapped graphics on DIN A4, DIN B5, letter- and legal-size paper; and optional Epson, Diablo, HPGL (HP graphics language), and IBM ProPrinter command and font emulations. $2495.

Data Technology Corp, 2551 Walsh Ave, Santa Clara, CA 95051. Phone (408) 727-8899. TLX 4745044.

Circle No 376



CPU CARD

- *Runs a 10-MHz 68008 μP*
- *Has monitor/debugger and real-time operating system support*

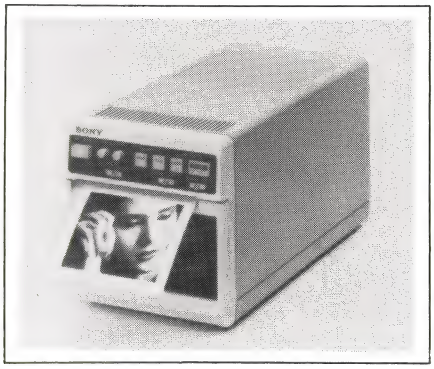
The 10681-MCU is a single-Eurocard CPU card for the 8-bit Eurobus-E backplane bus, also known as the Intelligent I/O Channel (IIOC-bus) sub bus for VME Bus systems. The board has a 10-MHz 68008 μP and five byte-wide memory sockets into which you can install as much as 4M bytes of local EPROM or static RAM. The board has front-panel LEDs and pushbuttons to monitor and control CPU operation. Software support for the board includes the company's Testbug68k monitor/debugger and Microware's OS-9/68000-Professional multiuser, multitasking, real-time operating system. DM 790.

EKF - Elektronik - Messtechnik GmbH, Weidekampstrasse 1a, 4700 Hamm 1, West Germany. Phone (02381) 12630. TLX 828621.

Circle No 377

VIDEO PRINTER

- *Provides B/W prints in 9 sec*
- *Has 640×490-dot resolution with a 32-level gray scale*



The UP-811 is a thermal-transfer B/W video printer for medical, security, and instrumentation applications that require real-time prints. It can generate prints in 9 seconds wherever real-time video-based systems are in use. It provides 640×490-dot resolution with a 32-level gray scale. The unit produces 3.8×2.9-in. prints. In addition to a brightness and contrast control, it features a monitor mode that controls the video monitor's brightness and contrast, allowing you to match the monitor image with the printed

Plug-in power for VME!

Here's a fully featured 400-watt, triple-output power system that's configured for *direct connection* to the motherboard in your VME bus system. It's a standard MOSFET switcher that includes all the features you've come to expect from NCR Power Systems.

Switching frequency is 80 kHz, and the unit has protection against overvoltage, overcurrent, and input surges. It meets the stringent safety and EMI requirements established by UL, CSA and TUV (VDE). Packaging complies with the Eurocard standards defined in DIN-41494 and IEC-297 for plug-in attachment to the motherboard. Precise (±0.4%) line and load regulation and 75% efficiency make the unit ideal for data communications and processing applications.

Standard units can be modified by NCR for precise conformance to customer requirements.

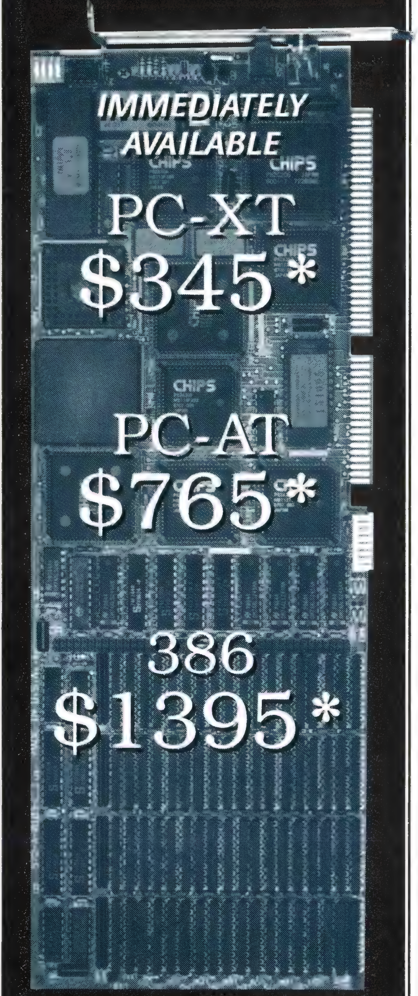
For detailed specifications and price quotation, contact NCR Power Systems, 3200 Lake Emma Road, Lake Mary, FL 32746; Telephone 800/327-7612 or in Florida, call 305/323-9250.

SEE US AT WESCON:
BOOTHS 150 & 152

NCR

CIRCLE NO 195

NEED SINGLE BOARD
PC-BUS
COMPUTERS?



IMMEDIATELY
AVAILABLE

PC-XT
$345*

PC-AT
$765*

386
$1395*

*100-up quantities

- **Reliable:** Low component count (50-60% fewer parts)
- **Efficient:** Low power requirements (AT and 386, 12 watts max at 5 VDC)
- **Modern design:** Passive backplane (Uses standard size plug-in cards)
- **Fast:** Selectable clock speeds on AT, 386 (AT to 10 MHz, 386 to 16 MHz)
- **Large memory capacities:** XT=640K, AT=1 Meg, 386=16 Meg!

Completely compatible single board computers from Texas Microsystems. For detailed specifications and prices, contact your nearest sales office, or

TEXAS MICROSYSTEMS
INCORPORATED
10618 Rockley Road • Houston, Texas 77099
(713) 933-8050
*Designers and manufacturers of **quality** computers for more than a decade*
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CIRCLE NO 35

image. The printer is UL-544 approved and FCC Class B certified. It is also available in a CCIR (International Radio Consultative Committee) and a NTSC version. $1100.

Sony Corp of America, Component Products Div, 10833 Valley View St, Cypress, CA 90630. Phone (714) 229-4181.

Circle No 378

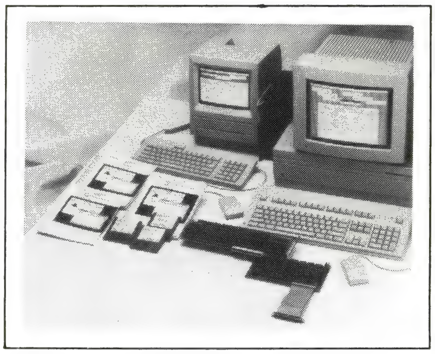
32-BIT µP

- *Runs on the Unix 386*
- *Operates with IBM PC, PC/XT, and PC/AT*

The Ivy 386 Series' Model 40 is a 32-bit µC for stand-alone or multiuser applications. Its operating system, the PC-MOS/386, can run single-user IBM programs such as Lotus and Wordstar. As many as 24 of the company's graphics workstations can access multiuser versions of Supercalc 4, Word Perfect, dBase III, and Focus. The µC can also run the Unix 386 operating system for 32-bit Unix programs. IBM PC, PC/XT, PC/AT, and compatible boards can operate the computer. Standard features include an 80386 µP, running at 16 MHz or 20 MHz; a 40M-byte hard-disk drive; a 1.2M-byte floppy-disk drive; 2M bytes of RAM on a mother board containing one 32-bit slot, five 16-bit slots, two 8-bit slots, and an 80387 socket; and a 220W power supply. $2995. Optional devices: high-resolution monochrome monitor, $255; EGA color monitor, $695; 40M-byte streamer tape drive, $495.

Ivy Microcomputers Corp, 15 Ararat St, Worcester, MA 01606. Phone (617) 853-6914. TLX 928446.

Circle No 379



ACQUISITION BOARD

- *Mac II board possesses eight differential analog inputs*
- *Has 12-bit resolution with six software-selectable ranges*

The ACM2-12-8A is a data-acquisition board for the Macintosh II. It has a 12-bit A/D converter with six software-selectable voltage ranges: ±25 mV, 50 mV, ±250 mV, 500 mV, ±5V, and 10V; an autorange feature automatically selects the best range. Its inputs are protected to 50V continuously and 150V momentarily. The board includes thermocouple cold-junction compensation and linearization for 10 thermocouple types: E, J, K, T, B, R, S, C, D, and G. The board is capable of transferring data to memory at a 10,000-sample/sec rate. Two optional analog outputs have 12-bit resolution. The outputs are protected from shorts to ground or power supplies. The board also has eight digital I/O lines that are individually selectable as inputs or outputs. The analog inputs and outputs are self-calibrated and use an onboard reference that is guaranteed for two years. $1190.

Strawberry Tree Computers Inc, 150 N Wolfe Rd, Sunnyvale, CA 94086. Phone (408) 736-3083. TWX 610-317-2834.

Circle No 380

INTRODUCING FUJITSU'S
NEW 8″ DISK DRIVE.

Our best performance numbers yet.

Our new 8″ Winchester offers an improved access time of 16ms. 690MB of storage. And 35,000 hours MTBF.

Three of the best numbers in the business. That's quality. That's reliability. That's the performance you should demand. And we're delivering production quantities.

It's SCSI compatible, too. Because our Intelligent Disk Controller provides single-ended or differential drivers and Common Command Set support for easy integration.

Model	M2322K	M2333P	M2333K	M2344K
Capacity	168 MB	337 MB	337 MB	690 MB
Access Time	20 ms	20 ms	20 ms	16 ms
Transfer Rate	1.229 MB/s	2.46 MB/s	2.46 MB/s	2.46 MB/s
Interface	SMD	IPI-2	HSMD/SCSI	HSMD/SCSI

What's more, our new 8″ disk drive has a dual-supported spindle that improves thermal off-track performance. And greatly increases shock tolerance.

So call for more information. On this or any of our famous family of data storage products, including Winchester, tape, optical and flexible drives. 408-432-1300.

Or write Fujitsu America, Computer Products Group, 3055 Orchard Drive, San Jose, CA 95134-2017.

You'll find we have all the right numbers.

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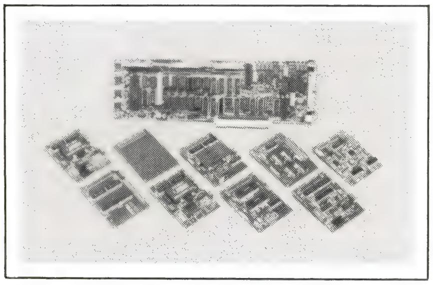


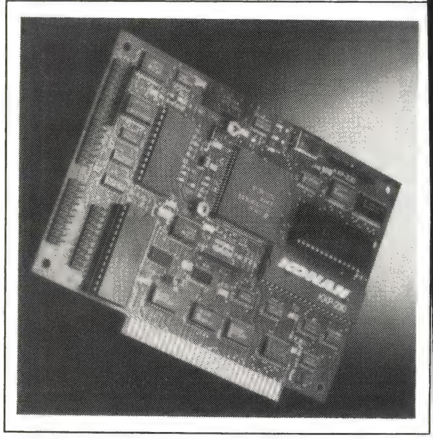
DATA ACQUISITION

- *10-board set for Macintosh II*
- *Analog input acquisition of 883,000 samples/sec*

The MacADIOS (Macintosh A/D input/output system) II is a 10-board set that provides an interface for analog and digital signals to the Macintosh II. It consists of the MacADIOS II card, which occupies one expansion slot, and nine daughter boards, which attach to the first card. The MacADIOS II can sample 12-bit data through one channel at a 142,000 sample/sec rate. The conversion time is 5 µsec with ±0.02% accuracy. A software-programmable instrumentation amplifier has three gain settings: ×1, ×10, ×100. An AM9513A counter/timer chip lets five 16-bit counters handle frequency and pulse-width measurements and event counting. The optional nine daughter boards provide increased performance features such as analog input acquisition at 833,000 samples/sec; high-resolution (16-bit) analog input or output at 50,000 samples/sec; analog multiplexing with 32 single-ended or 16 differential input channels; digital input or output with 16-bit parallel ports; and software-controlled antialiasing filters. Each MacADIOS data-acquisition board can hold as many as three daughter boards. MacADIOS II card, $1290; daughter boards, $65 to $1425.

GW Instruments Inc, Box 2145, Cambridge, MA 02141. Phone (617) 625-4096.

Circle No 381



HARD-DISK CONTROLLER

- *Compresses files of repetitive data by as much as 800%*
- *Supports as much as 302M bytes of hard-disk storage*

The Model KXP-230 hard-disk expander increases the drive capacity of the IBM PC, PC/XT, PC/AT, Tandy 1000/3000, and compatible computers. The hard-disk controller uses data-compression and file-com-

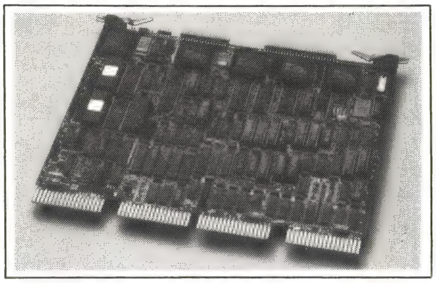
Nobody else now offers you the complete line of GE/RCA low-power thyristors.

Nobody.

paction techniques that compress files of repetitive data by as much as 800%. It can be used with any ST-506/412 compatible hard disk and supports as much as 320M bytes of storage. Data is stored on the disk in modified frequency modulation (MFM) format. The controller features a disk cache to decrease access time; error correction; and fragmentation control, which allows files to be placed in the next available contiguous location. During installation a software program separates the hard disk into an MS-DOS partition and a compacted user-data partition called EDISK (expanded disk). A 20M-byte hard disk has 1M bytes of bootable DOS and as much as 38M bytes of Edisk. Versions for IBM PC, PC/XT, and Tandy 1000, $249; IBM PC/AT version, $299.

Konan Corp, 4720 S Ash Ave, Tempe, AZ 85282. Phone (602) 345-1300. FAX (602) 345-2829.

Circle No 382



OPTICAL-DISK KIT

- *Reduces time needed to connect optical disk to MicroVAX II*
- *Single-board controller provides SCSI port*

This optical development kit helps to reduce the time it takes to connect an optical disk to a MicroVAX II μC. It includes an SMS 0109 Q bus single-board optical disk controller; an 800M-byte 5¼-in. optical disk; Optical System Software for the VMS operating system; and cables. The disk controller provides a SCSI port that connects the optical disk to the computer. It has a proprietary chip set that provides simultaneous access to multiple devices. The controller also supports two ESDI or two ST412 fixed Winchester disk drives. The optical disk is the Maxtor RXT-800S 5¼-in. drive. It is a write-once-read-many (WORM) device that provides 800M bytes of storage on a double-sided removable media. The drive has an embedded SCSI controller that communicates with the single-board controller and provides error detection and correction. The software implements a file structure similar to DEC's ODS-2 file structure, a utility to manage the optical disk, and a set of routines accessible by application programs. Kit, $10,000; single-board controller, $1150 (OEM qty).

Scientific Micro Systems Inc, 339 N Bernardo Ave, Mountain View, CA 94043. Phone (415) 964-5700.

Circle No 383

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CIRCLE NO 36

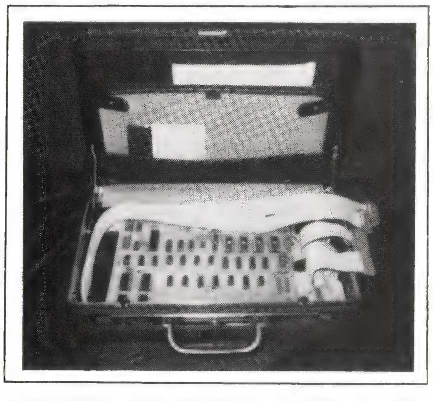
VME BUS SBC

- *Features a 68020 CPU and a 6881 FPU*
- *Uses a 16-MIPS RISC μC for DMA*

The VME32QX is a single-board workstation for the VME Bus. It features a 68020 μP, running at 16 MHz or 20 MHz; a 68881 floating-point unit (FPU); a 68551 paged memory-management unit (PMMU); as many as 4M bytes of onboard RAM; and a 16-MIPS DMA controller that uses RISC technology. The DMA controller has full access to onboard and VME memory and can transfer data at 80M bytes/sec. Its hardware allows detection of a peripheral interrupt, rescheduling, and task switching in 100 nsec. The DMA controller handles the low-level protocols used in Ethernet, X.25, and SCSI interfaces and controls access to a battery-backed clock, nonvolatile memory, and a keyboard or a mouse. £3995.

Torch Computers Ltd, Abberley House, Great Shelford, Cambridge CB2 5LQ UK. Phone (0223) 841000. TLX 818841.

Circle No 384



DEVELOPMENT MODULE

- *Firmware for 8-bit μP boards*
- *High-speed RAM is cabled directly to ROM*

The pdm/8 is a development module that develops firmware for any 8-bit μP-based board. Its high-speed RAM is cabled directly into the board's ROM socket(s) and can assume configurations for as many as four 27(C)64, two 27(C)128, or one 27(C)256 EPROMS. Eleven menu-driven modes include EPROM programming (with standard, intelligent, and quick-pulse algorithms); host upload and download capabilities; editing; and data manipulation. The development module uses memory substitution instead of μP emulation. You can combine the module with any μC with terminal-emulation software and cross-assembler software so that your design μP can enter assembly-language code, create an object file, and debug. This special-function computer is mounted on a pc board and housed in an attache case with storage pockets for diskettes and papers. It can be custom ordered for use with breadboards, terminals, PCs, and printers. $995.

Advanced Software Machine Systems, Box 31131, Sarasota, FL 33582. Phone (813) 351-4188.

Circle No 385

GRAPHICS CARD

- *Based around 63484 advanced CRT controller*
- *Color look-up table is available*

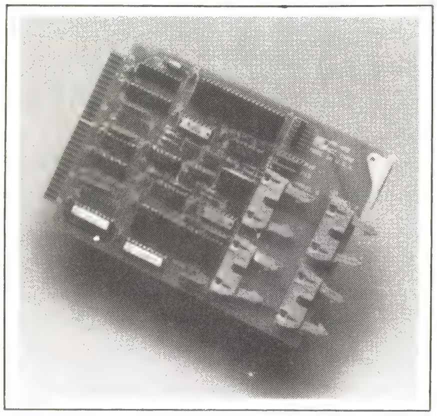
The VGPM is a single-Eurocard VME Bus board using an 8-MHz 63484 advanced CRT controller chip and 1M byte of graphics memory to provide graphics displays with 1280×1024-pixel resolution. You can reconfigure the board to provide other screen resolutions. The standard version displays 16 fixed colors, but you can add a color look-up table to display 16 colors from a palette of 4096 colors. The board supports interlaced displays at a pixel frequency of 32 MHz or noninterlaced displays at a pixel frequency of 64 MHz. A front-panel, 9-pin subminiature D connector provides TTL-level video outputs. Miniature BNC connectors provide a front-panel analog RS-343A RGB output on the model with the color look-up table. From $999 to $1499 (OEM qty).

Pep Modular Computers GmbH, Am Klosterwald 4, 8950 Kaufbeuren, West Germany. Phone (08341) 8974. TLX 541233.

Circle No 386

Pep Modular Computers Inc, 600 N Bell Ave, Pittsburgh, PA 15106. Phone (800) 228-1737; in PA, (800) 255-1737. TLX 825098.

Circle No 456



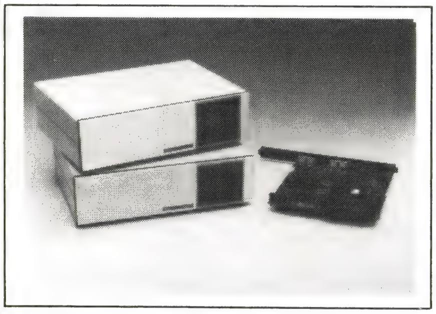
COMMUNICATIONS CARD

- *Full-duplex RS-422A/485 channels for the STD Bus*
- *Baud rates to 1.2M synchronous, 76.8 asynchronous*

The 7315 is a serial communications card for the STD Bus. It provides four independent RS-422A/485 serial channels. One version of the card supports 8088 CPU-based systems, and the other supports Z80- or 8085-based systems. As many as 32 STD Bus systems can be linked using the multidrop RS-485 interface combined with programmable recognition. The card offers synchronous and asynchronous protocols and features baud rates as high as 1.2M baud synchronous and 76.8 baud asynchronous. The card can generate prioritized vectored interrupts from external or on-card sources. You can design communications diagnostics using a local-loopback mode. $250.

Pro-Log Corp, 2560 Garden Rd, Monterey, CA 93940. Phone (800) 538-09570; in CA, (408) 372-4593.

Circle No 387



VOICE/DATA MUX

- *Digitizes as many as four voice signals*
- *Voice and digital data becomes a 56k-bps digital link*

The Oneliner multiplexes multiple synchronous and asynchronous data channels and as many as four 9.6k-bps voice channels over a single digital data link. It has two full-duplex voice digitizing cards. Each card converts two analog voice signals into a 9.6k-bps digital stream. This stream is then multiplexed with data from digital channels to provide a 56k-bps digital link for transmission over satellite, fiber, microwave, or T1 circuits. Internal echo cancelers are included for operation in PBX applications. The voice-performance specifications include a 1×10^{-3} bit error rate; a 180-msec processing delay; 35-dB min echo suppression; and 1-sec max echo-suppression training. From $4635.

Micom Systems Inc, 4100 Los Angeles Ave, Simi Valley, CA 93063. Phone (805) 583-8600. TWX 910-494-4910. TLX 687497.

Circle No 388

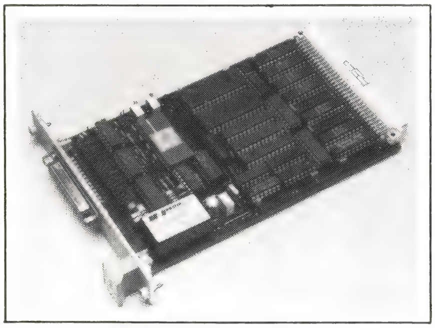
PC ADD-IN

- *Interfaces an IBM-PC family to bridge transducers*
- *Includes outputs to energize the transducers*

The PCLVDT6 is a 6-channel signal conditioning and 12-bit A/D converter board for the IBM-PC, -PC/XT, -PC/AT, or compatible computers that allows you to interface the computer to linear variable differential transformer (LVDT) and resistive transducers. A single card can connect to a mix of half- and full-bridge transducers, with each of the six input channels jumper-selectable to have a single-ended or a differential input. You can software program each channel for ac or dc coupling, and you can software program the input amplifier to have a gain between ×1 and ×128. A synchronous demodulator is provided for ac inputs. Two additional input channels are provided so that you can calibrate the board's gain and offset errors. The A/D converter has 12-bit resolution, an accuracy of ±1 LSB, and a conversion time of 120 μsec. The board also provides transducer drive outputs. These outputs comprise a 5V/60 mA rms sinewave output that you can jumper select to frequencies of 410 or 700 Hz, or 1, 5, 7, or 14.3 kHz; plus 6V/60 mA and ±8V/80 mA regulated, and ±12V/100 mA unregulated dc outputs. The board is supplied with support software that runs under the PC-DOS and MS-DOS operating systems. £495.

NMI Electronics Ltd, 26 The Heathlands, Wombourne, Wolverhampton WV5 8HF, UK. Phone (0902) 895185.

Circle No 389

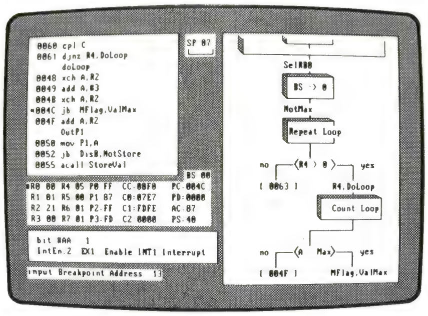


A/D BOARD

- *Provides 8- or 16-channel, 12-bit ADC on VME Bus*
- *Accepts piggyback signal conditioning modules*

You can configure the VADI single Eurocard VME Bus A/D converter board to have 16 single-ended, or 8 differential input channels. The board digitizes to 12-bit resolution

IBM-PC based microcomputer development tools!



```
 0060 cpl C
 0061 djnz R4,DoLoop
      doLoop
 0048 xch A,R2
 0049 add A,#3
 004B xch A,R2
*004C jb  MFlag,ValMax
 004F add A,R2
      OutP1
 0050 mov P1,A
 0052 jb  DisB,NotStore
 0055 acall StoreVal
```

```
SP 07
BS 00
*R0 00 R4 05 P0 FF  CC:00F0  PC:004C
 R1 01 R5 00 P1 B7  C0:07E7  PD:0000
 R2 21 R6 01 P2:FF  C1:FDFE  AC:B7
 R3 00 R7 01 P3:FD  C2:0000  PS:40
```

```
bit #AA   1
IntEn.2  EX1  Enable INT1 Interrupt
```

```
input Breakpoint Address  13
```

(8051 debug/simulator shown)

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8096	✓	✓	✓
8051	✓	✓	✓
8049	✓	✓	✓
7000	✓	✓	✓
8088	✓		✓
8085		✓	✓
320		✓	✓
Z8		✓	✓
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Step your code, watch registers & memory change, interrupts occur, stack push & pop. Flowgraph auto-documents code! You set breakpoints & register traps, count machine cycles, and scan source code and symbols. Single-key commands prompt for arguments if needed. Have more fun and get more done!

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Cybernetic Micro Systems
P.O. Box 3000
San Gregorio, CA 94074 U.S.A.

(415) 726-3000 • Telex 171135 Attn: Cyber

CIRCLE NO 37

Designing a better communications board was easy...

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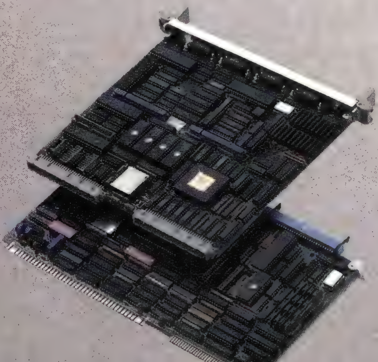
Like multiple wattages in one bulb.

Or multiple communications protocols on one board.

After all, you don't just use one protocol, so why buy a controller board that offers only one? With Central Data's Intelligent Communications Controllers using our Communications Monitor Firmware, you've got a built-in three-way connection.

Utilizing an 80186 processor and optional on-board Communications Monitor Firmware, our Models CD21/3518 (Multibus* I) and CD22/3800 (Multibus II) provide the flexibility to handle asynchronous, X.25, and SNA communications protocols co-existing on a single board under firmware control. (SNA will be available on CD22/3800 in 1988.)



That's flexibility.

You can even write your own protocols. On-board memory includes 512K of parity protected dynamic RAM and up to 256K of EPROM, and communications protocols downloaded to the board run under control of the Communications Monitor Firmware. That augments the effective power of your system, since the communications controller takes over most of the host processor's communications tasks.

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To shed more light on Central Data's Intelligent Communications Controllers, and our other products for Multibus and VME users, call our Product Manager Jeff Tieri. He'll talk specs and prices, and send you a brochure with full product and performance details. Reach him, toll-free, at 1-800-482-0315 (217-359-8010 in Illinois).

Or write us, Central Data, 1602 Newton Drive, Champaign, IL 61821-1098.

Central Data

*Multibus is a trademark of Intel Corporation

CIRCLE NO 207

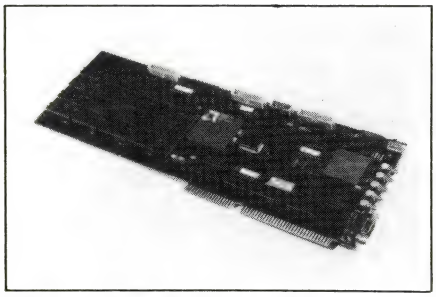
and has a conversion time of 8 μsec. It provides 5, 10, ±5, and ±10V input ranges and has a programmable gain amplifier that you can software program to a gain of ×1, ×10, ×100, or ×1000. The inputs are overvoltage protected to ±20V. Digitized readings are automatically transferred into a 2k-byte FIFO buffer, and you can generate software-programmable VME Bus interrupts to indicate available readings in the buffer. You can add optional piggyback signal-conditioning modules to provide ±30V input protection, and a separate single-ended or a separate differential input amplifier for each input channel, or 16 ±10 mA current inputs. The board is also compatible with Analog Devices' 3B and 5B series of signal conditioning modules. Around $900.

Pep Modular Computers GmbH, Am Klosterwald 4, 8950 Kaufbeuren, West Germany. Phone (08341) 81001. TLX 541233.

Circle No 390

Pep Modular Computers Inc, 600 North Bell Ave, Pittsburgh, PA 15106. Phone (412) 279-6661. TLX 825098.

Circle No 391



GRAPHICS BOARD

- *Uses the AMD 95C60 data-flow manager*
- *Raises IBM PC/AT graphics to workstation performance*

The 7000CB is a graphics controller card for the IBM PC/AT for high-end workstation performance. It contains one or two AMD 95C60 Quad Pixel Dataflow Managers (QPDM) as graphic engines. This engine allows data for each pixel plane (with a resolution of 1280×1280 pixels) to be accessed in parallel. The unit can thus maintain the same draw times no matter how many planes are addressed. Typical draw times are 100,000 vectors/sec and bit-block transfers occur at the rate of 18.2 million pixels/sec. The board has 1280×1024- or 1024×780-pixels displayable resolution. The standard color palette allows 16 colors out of 4096. A color palette option is available, which attains 256 out of 16.7 million colors. It utilizes a Brooktree DAC (BT458/451) and an invisible pixel memory to 4M bytes of RAM, which can store lists and data for recurring polygons. The board can be configured as

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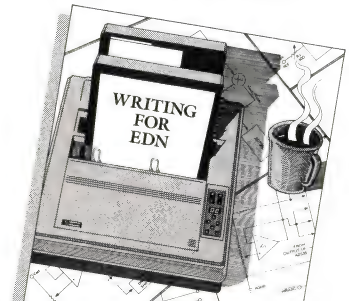

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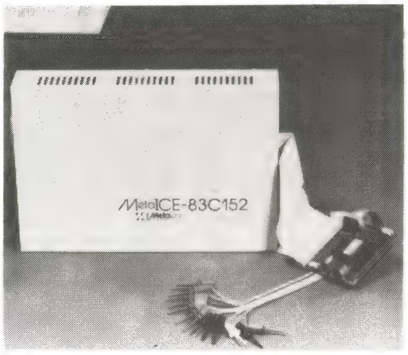


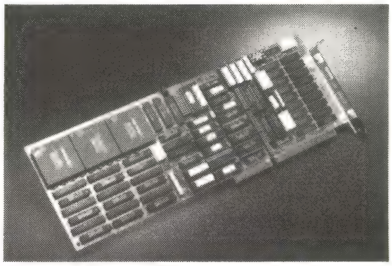
EMULATOR

- *Emulates the 83C152 and 80C152*
- *Runs on IBM PC/XTs and PC/ATs with 640k bytes of RAM*

The MetaICE-83C152 is an in-circuit emulator for the Intel 83C152 and 80C152 single-chip microcontrollers. It can perform real-time and transparent emulation at 12-MHz rates on the IBM PC, PC/XT, PC/AT, and compatibles. The unit requires 640k bytes of RAM, two floppy-disk drives, and an RS-232C interface. It supports all modes of the 83C152: single-line assembly and disassembly; 4k×32-bit real-time traces; 128k hardware breakpoints on as many as 16 triggerable events, including PC addresses and read or write operations to a direct byte or direct bit; and conditional and logic statements. You can also download executable code to 64k bytes of program overlay and download external data to 64k bytes of external data-overlay memory. Using an adapter card, the device can also emulate 8051, 8031, 8751, 8053, and 8753 microcontrollers. It costs $3995, including a probe card, an emulation base, a company application system, and an ASM51 macro cross-assembler.

MetaLink Corp, Box 1329, Chandler, AZ 85224. Phone (800) 638-2423; in AZ, (602) 926-0797. TLX 4998050.

Circle No 393



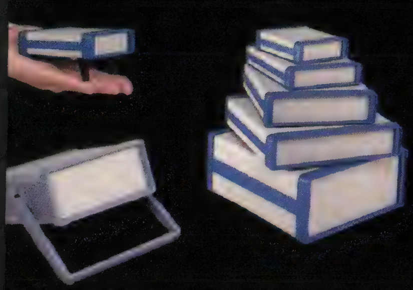
COPROCESSOR BOARD

- *Cache, integer processor, and FPU deliver 20M flops*
- *Runs on IBM PC/AT and Apollo Series 3000/4000*

The MC3200AT is a single-board coprocessor that can accelerate computation-intensive vector and scalar operations on the IBM PC/AT and the Apollo Series 3000/4000 workstations. The 2M-byte main memory combined with a cache, an integer processor, and a floating-point unit (FPU) provides 32-bit floating-point operations for a 20M-flops performance. The main memory can be expanded in increments of 2M, 4M, or 8M bytes with an optional daughter board that connects directly to the board. The board can do a 1024-point (complex) FFT in 3.4 msec. For image-processing applications the board can convolve a 3×3-pixel filter on a 512×512-pixel image in 255 msec. For modeling and simulation, it can multiply a 100×100-dot matrix in 125 msec. The board draws 15W of power fully configured. With 2M-byte dynamic RAM, $8000; with ½M-byte dynamic RAM, $6500.

Mercury Computer Systems Inc, Wannalancit Technology Center, 600 Suffolk St, Lowell, MA 01854. Phone (617) 458-3100. TLX 311515.

Circle No 457



SL/L SERIES—small to medium size metal stand-alone enclosures

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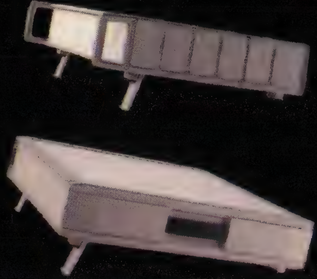
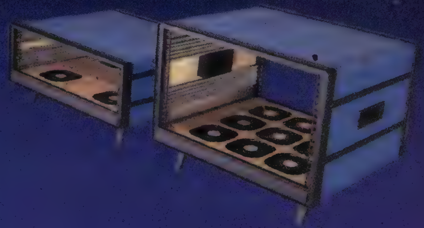


R/SR SERIES—rack mountable or stand-alone die cast aluminum enclosures

TRACEWELL enclosures inc **CIRCLE NO 209**

CH SERIES—chassis type, 19 inch rack mounted enclosures

TRACEWELL enclosures inc **CIRCLE NO 210**



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ET SERIES—subracks and accessories for VME bus® and STD systems

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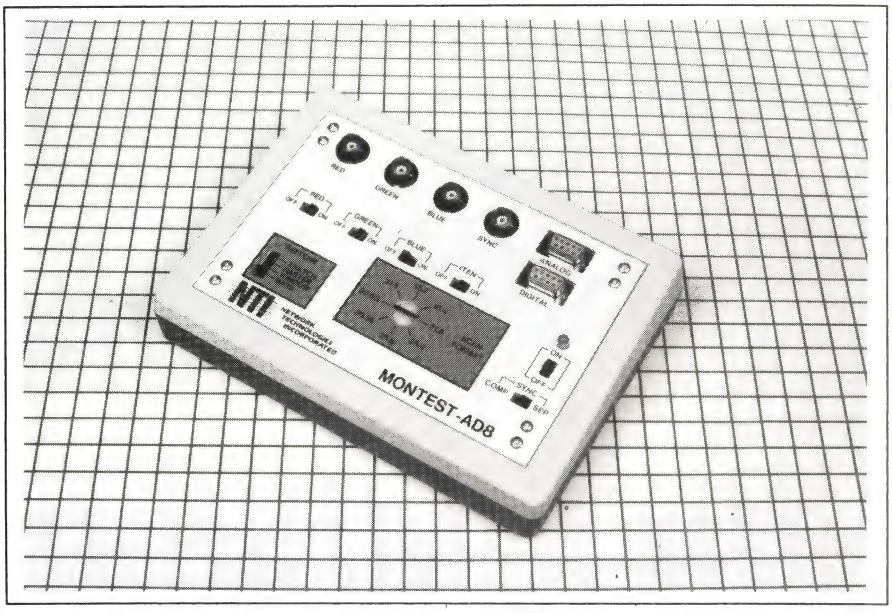


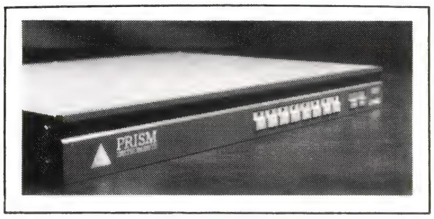
VIDEO GENERATOR

- *Tests MDA, EGA, PGA, and multisynchronous monitors*
- *Has connectors matching all compatible displays*

The Montest-AD8 video generator uses an 8-MHz dot clock to generate four test patterns—full raster, color bars, cross hatch, and windows—at any of eight user-selectable scan frequencies from 15.75 to 31.5 kHz. It tests MDA (Monochrome Display Adapter), EGA (Enhanced Graphics Adapter), PGA (Professional Graphics Adapter), and multisynchronous monitors. The output appears simultaneously on three connectors—BNC, 9-pin D analog, and 9-pin D digital—and has connectors matching all compatible displays. Sync is available on a separate BNC; composite sync is switch selectable. The unit is battery powered, but you can operate it from the ac line using a plug-in transformer supplied with it. $875.

Network Technologies Inc, 19145 Elizabeth St, Aurora, OH 44202. Phone (800) 742-8324; in OH, (216) 543-1646.

Circle No 409



IEEE-488 CONTROLLER

- *Controls as many as 28 IEEE-488 instruments*
- *Executes programs contained in EPROMs*

Targeted for use in repetitive testing applications—for example, in component test systems, burn-in racks, or environmental chambers—the Gamma IEEE-488 slave controller can control as many as 28 instruments on its two IEEE-488 ports, using preprogrammed sequences stored in internal RAM or in EPROMs. You can execute any one of eight program sequences by pressing the unit's front panel pushbuttons. Program sequences are either downloaded into the controller's internal RAM via its RS-232C interface or installed by plugging in EPROMs. £595.

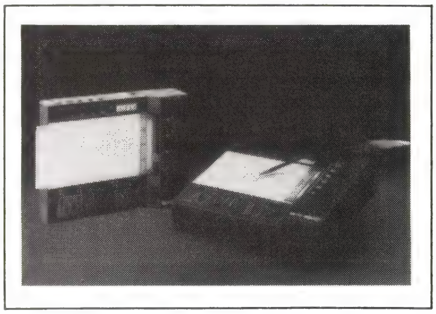
Prism Instruments Ltd, Burrel Rd, Industrial Estate, St Ives, Huntingdon, Cambridge PE17 4NF, UK. Phone (0480) 62225. TLX 32303.

Circle No 410

RECORDERS/DMMs

- *Power from ac line, 12V dc, or internal battery*
- *Measure and record ac, dc voltage, current*

The SE110 and SE111 recorders provide both analog chart recording and digital readout of the measured value. The SE110 handles full-scale readings from 1 mV to 500V in 18 ranges and offers variable scaling and as much as two times full-scale zero suppression. The SE111 sacrifices the zero suppression and some sensitivity but adds 12 ac-voltage, ac-, and dc-current ranges; full scale can be as low as 150 mV ac or dc or 600 μA ac or dc, and as high as 750V ac or dc or 6A ac or dc. The units accommodate roll charts and individual paper sheets; they also include an internal battery charger. The printed codes indicate range, chart speed, and battery status. You can remotely raise and lower the pen and control all chart-drive functions. SE110, $995; SE111, $1095.



BBC-Metrawatt/Goerz, 2150 W 6th Ave, Broomfield, CO 80020. Phone (800) 821-6327; in CO, (303) 469-5231. TLX 4970869.

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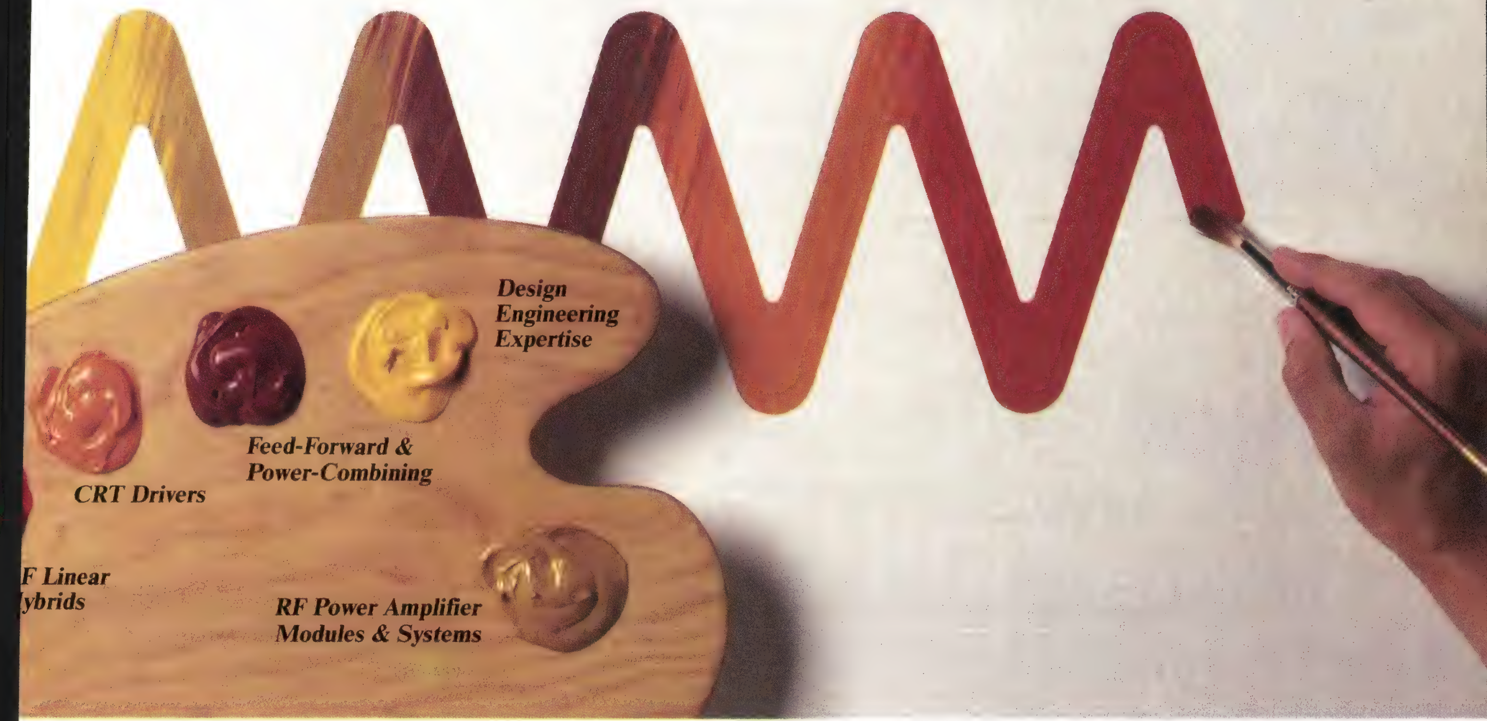

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TRW

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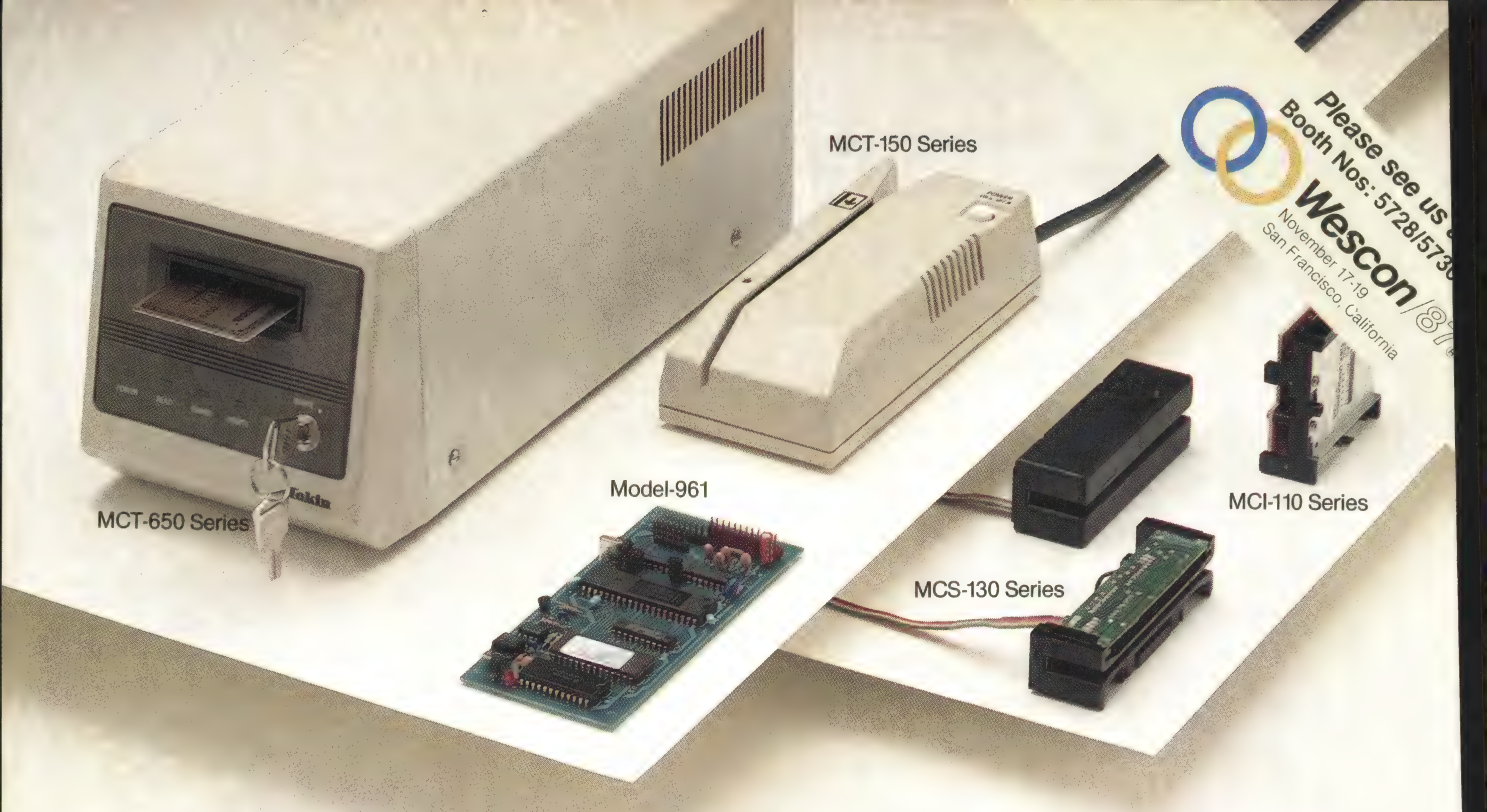


Tokin. The magnetic name in card systems.

Tokin makes the finest, most complete magnetic card systems anywhere. From the material in the magnetic heads of card readers/writers, to intelligent interface modules, to the best in magnetic cards.

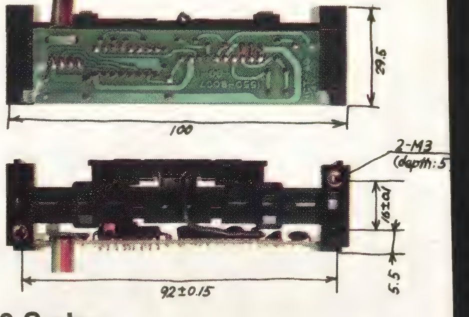
A simple RS232C personal computer connection lets you use our MCT-650 Series motorized magnetic card reader/writers for easy data readout/printout. Just like our MCT-150 Series manually-operated card readers.

Or if you'd prefer to design your own card readers, check out our MCI/MCS Series card reader units with original integrated circuits and exclusive magnetic heads for a vast range of applications. Or our all-new Model 961 magnetic card reader interface module that connects to an RS232C interface.

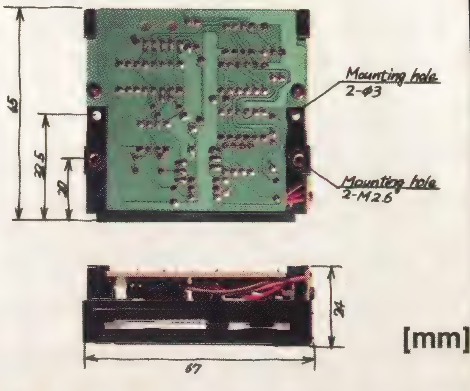
So whether it's card readers you're interested in, or the internal workings to make them yourself, remember: Tokin offers the finest card reader technology anywhere. And results you can count on.

Shapes and Dimensions

MCS-135, 136



MCI-110 Series



[mm]

Interface of MCT-650, MCT-150 Series and Model-961

	MCT-650 Series	MCT-150 Series	Model-961 Interface Module
Communication standards	Standard EIA, RS232C		
Communication mode	Start-stop synchronization, full duplex (half duplex)	Start-stop synchronization, full duplex	Start-stop synchronization, full duplex (half duplex)
Transmission speed (baud)	1,200/2,400/4,800/9,600	1,200	600/1,200/2,400/4,800/9,600/19,200/38,400
Communication format	Start bit 1 Data bit 8 Parity (even) 1 Stop bit 1		Start bit 1 Data bit 7 Parity (odd) 1 Stop bit 1 (User selectable)
Card driving system	Motorized	Manual	—
Performance	Read/write	Read only	
Power supply	117V AC		+5V DC, +8~12V DC

Applicable Magnetic Card

Units	Card Standard	Dimensions (mm)
MCI-111	ISO, track 2	24×61×65
MCI-112	ISO, track 1	
MCI-113	ISO, track 3	

Units	Card Standard	Dimensions (mm)
MCS-131(E)	ISO, track 2	27×29.5×100 (32.5×32×100)
MCS-132(E)	ISO, track 1	
MCS-133(E)	ISO, track 3	
MCS-135(E)	ISO, track 1 and 2	
MCS-136(E)	ISO, track 1 and 2	

*(E): With cover

Tokin

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Tokyo 107, Japan
Tel: Tokyo (03) 402-6166
Fax: Tokyo (03) 497-9756
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Tokin America Inc.

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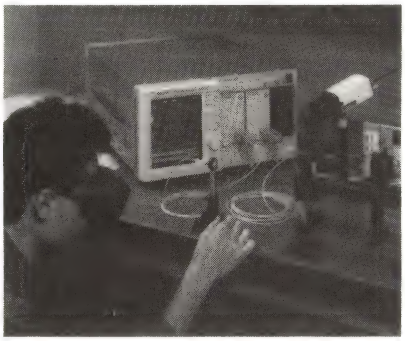

OPTICAL PROBES

- *Convert optical signals to drive scope*
- *Handle 700-MHz modulation*

The P6701 and P6702 converters perform optical/electrical power conversion in a package the size of a probe-compensation box and provide a scope with waveforms for acquisition, display, measurement, and analysis. The P6701 responds to light wavelengths from 450 to 1050 nm; the P6702 response is from 1000 to 1700 nm. The P6701 and P6702 handle modulations as high as 700 and 500 MHz, respectively. The vendor's scopes supply all the power needed by the converters. By using the companion P6751 spatial-input head, a tunable, bench-mountable lens system, you can convert laser beams to scope inputs. P6701, $1800; P6702, $1995; P6751, $295.

Tektronix Inc, Marketing Communications Dept, Box 1700, Beaverton, OR 97075. Phone (800) 547-1512; in OR, (800) 542-1877.

Circle No 412

COMB GENERATOR

- *Covers 1 to 40 GHz*
- *Has 1-GHz frequency spacing between comb outputs*

The Model 1040A comb-frequency generator operates from 1 to 40 GHz in three bands: 1 to 18 GHz, 8 to 26.5 GHz, and 26.5 to 40 GHz. The output power for the three bands is −5 to +15 dBm, −25 to −5 dBm, and −35 to −25 dBm, respectively. The standard frequency spacing be-

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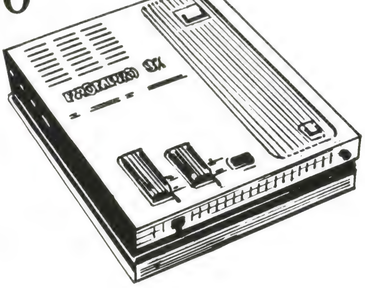

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CIRCLE NO 49

C
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  - Object Code Librarian
  - Object Module Linker
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- All languages can be intermixed with assembly language
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  - **6801/03**
  - **6809**
  - **68HC11**
  - **68000/08/10/12**
  - **68020/881/851**
  - **32000/32/81/82**
- Available for following hosts:

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PDP-11: UNIX/TNIX/VENIX
68000: UNIX System V
PC,XT,AT: MS-DOS
PowerNode: UTX/32

UNIX: TM of AT&T Bell Labs.
VAX, VMS, PDP-11, ULTRIX: TM of Dig. Equip. Corp.
TNIX: TM of Tektronix Inc.
VENIX: TM of VenturCom
PowerNode, UTX/32: TM of Gould Inc.

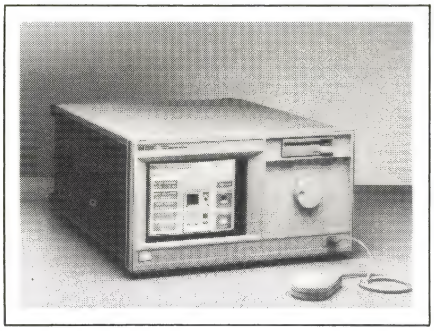
INTROL CORPORATION
647 W. Virginia Street
Milwaukee, WI 53204
(414) 276-2937
FAX: (414) 276-7026

CIRCLE NO 50

tween comb outputs is 1.0 GHz; 100- and 500-MHz spacings are available. The unit is ac powered, measures 5×9×7.6 in., and is transportable. $7900 (small quantities).

ST Research Corp, 8419 Terminal Rd, Newington, VA 22122. Phone (703) 550-7000. TWX 710-832-9818.

Circle No 413



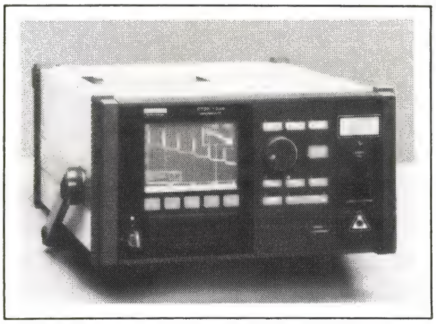
LOGIC SYSTEM

- *Comprises analyzer, scope, and generator*
- *Software links system to CAE workstations*

The modular and user-configurable HP 16500A logic-analysis system comprises a 100-MHz timing logic analyzer, a 25-MHz state logic analyzer, a dual-channel 400M-sample/sec digitizing scope, a 50M-bps pattern generator, and a 1-GHz timing analyzer. The system's mainframe accepts as many as five pc boards. The various functions are provided by modules that comprise different numbers of boards. All of the instrument pc boards can cross trigger. The system's front panel features a 9-in. color, touch-sensitive CRT, which displays a menu-oriented control system. The unit also has two disk drives for measurement setups and data storage. Each single-board, state/timing logic-analyzer module provides 80 channels. The single-board digital analyzer has two 4k-sample memories. The single-board, 1-GHz timing analyzer has 16 channels. The scope and analyzers require special probes. The pattern generator provides 12 channels (48 channels with the optional expander), and each channel has a 4k-bit pattern depth. The vendor offers communications software for linking to its proprietary CAE system. HP 16500A mainframe, $7200; HP 16510A timing/state analyzer, $5200; HP 16515A 1-GHz timing analyzer, $7800; HP 16520A pattern generator, $3700; 48-channel expansion, $4000; HP 16530A 400M-sample/sec scope timebase, $1500; HP 16531A scope, $4000; CAE link software, $2000. Delivery, one to three months ARO.

Hewlett-Packard Co, Inquiries Manager, 1820 Embarcadero Rd, Palo Alto, CA 94303. Call local office.

Circle No 414



FIBER TESTERS

- *Simplify testing of fiber-optic cables*
- *Include models to test multimode or monomode fibers*

Models 7721, 7723, and 7725 optical time-domain reflectometers allow you to make bandwidth and attenuation measurements for the installation and maintainance, production test, or length measurement of fiber-optic cables. The instruments use menu and automatic setups to achieve repeatable measurements of bandwidth, cable losses, and splice losses, and to locate breaks in the fiber. The CRT trace of the cable's characteristic is fully annotated with the losses. Initial cable profiles, optionally stored on a magnetic tape cassette, can be recalled for comparison purposes. An integral printer provides hard-copy results. A manual operating mode allows

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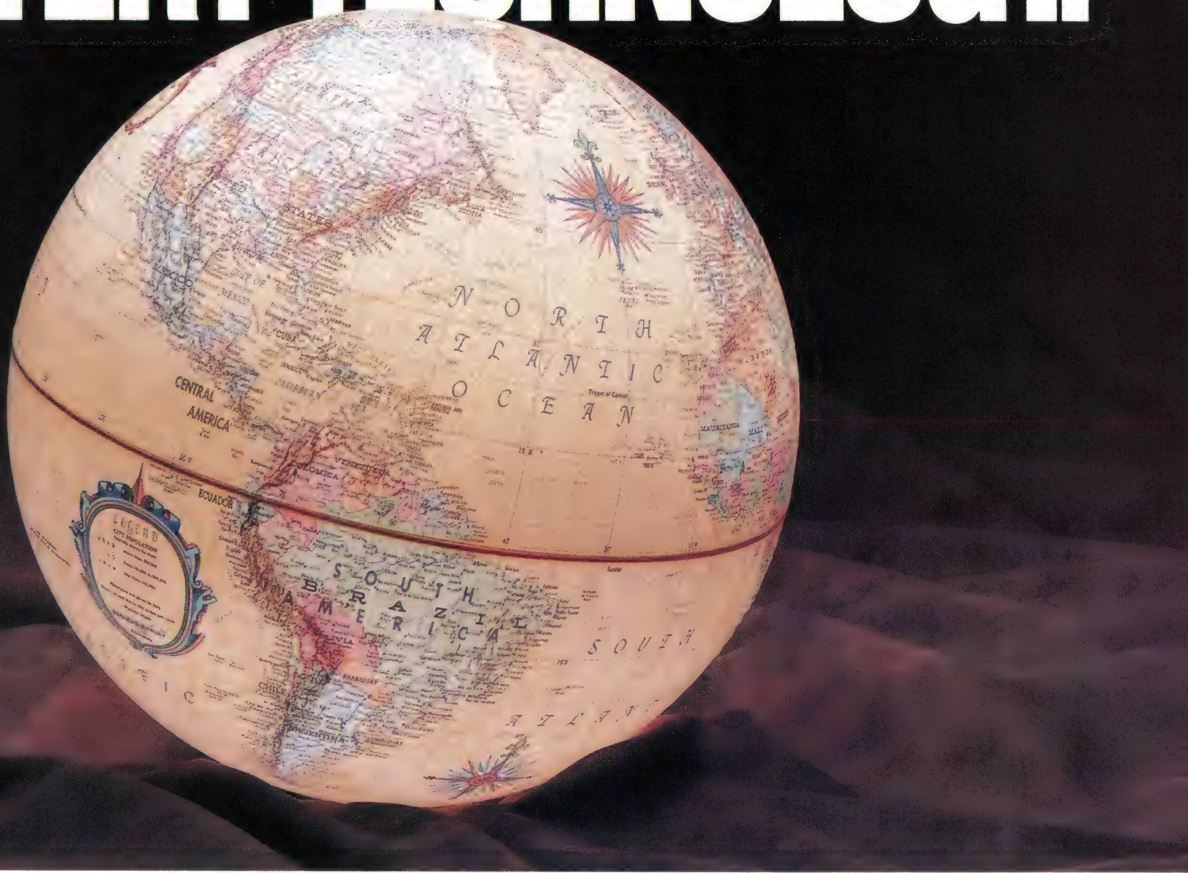

Gates Energy Products has purchased GE's Battery Business Department, making us the world's largest source of sealed rechargeable batteries.

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CIRCLE NO 217

more advanced users to make additional measurements and to zoom in on areas of special interest. Models 7721, 7723, and 7725 are designed for 850-nm multimode, 1300-nm multimode, and 1300-nm monomode cables, respectively. In the 7721, a special fiber connector accepts several cable sizes and reduces the dead zone in the fiber to zero. The instruments for use with multimode fibers feature a backscatter single-way dynamic range (SWDR) of >25 dB; and the monomode instrument specs a backscatter SWDR of >24 dB. All the instruments have IEEE-488 and RS-232C interfaces and operate from ac line or 10 to 16V dc supplies. £12,000 to £16,500.

Enertec Instruments, 5 rue Daguerre, 42030 St Etienne Cedex 2 France. Phone 77252264. TL 300796.

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Solartron Instruments, 2 Westchester Plaza, Elmsford, NY 10523 Phone (914) 592-9168. TLX 145487.

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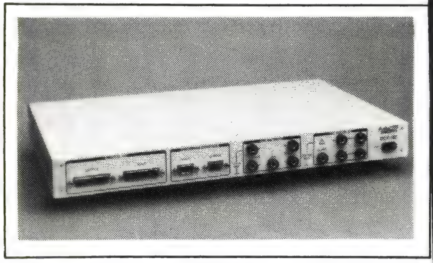


AUDIO TESTER

- *Can check 16- and 18-bit A/D and D/A audio gear*
- *Can execute tests under IBM PC control*

The DCX-127 module adds dc-voltage and resistance measurement capabilities, two dc outputs controllable over ±10V (20-μV resolution), and 21-bit digital I/O to the vendor's System One audio-test system. The unit incorporates an autoranging 4½-digit DVM. With this module, the system can automatically test audio equipment power supplies and can also check amplifier-offset voltage, loudspeakers, voltage-controlled amplifiers, and 16- or 18-bit A/D and D/A converters. $2150.

Audio Precision, Box 2209, Beaverton, OR 97075. Phone (503) 627-0832; in OR, (800) 231-7350. TLX 283957.

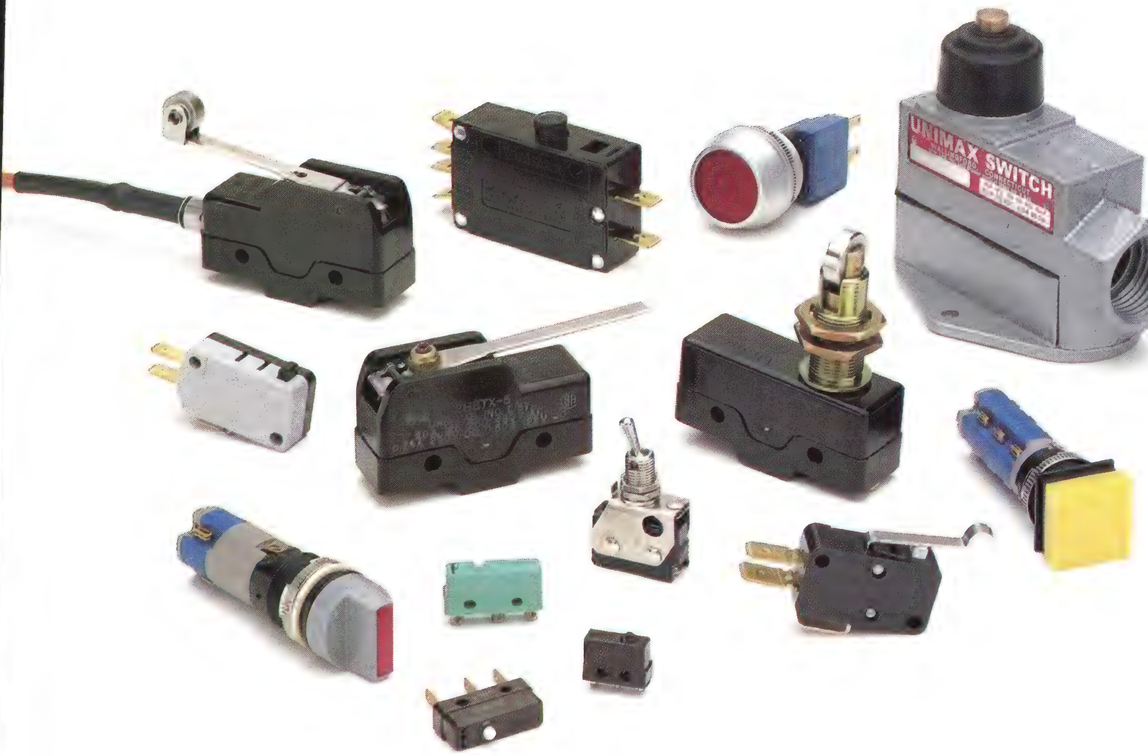
Circle No 417

VIDEO GENERATOR

- *Superimposes time/date information on a video image*
- *Has programmable character size and display formats*

The TDG-1 video time/date generator superimposes time or date information onto a video picture signal. You can move the time/date display around the screen area and select

Timing is everything.



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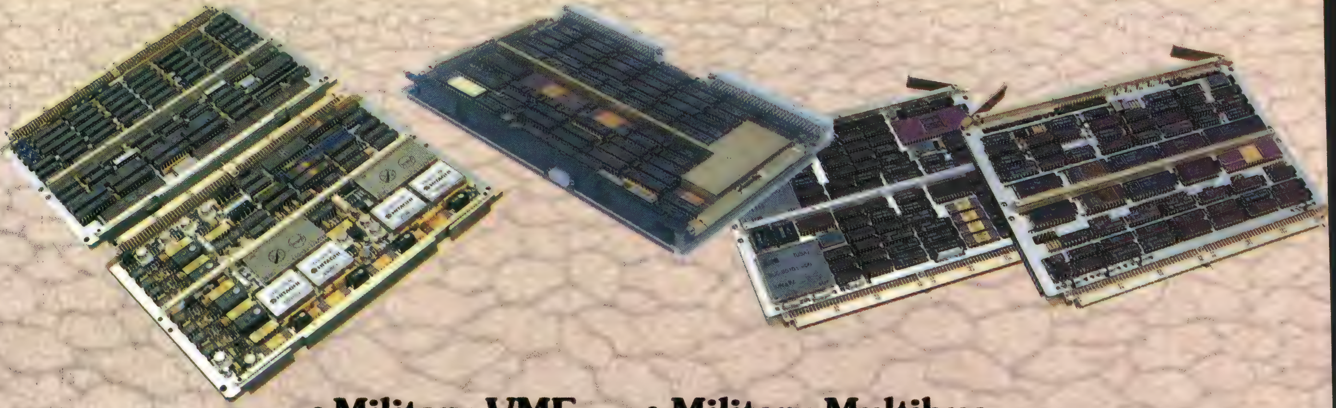

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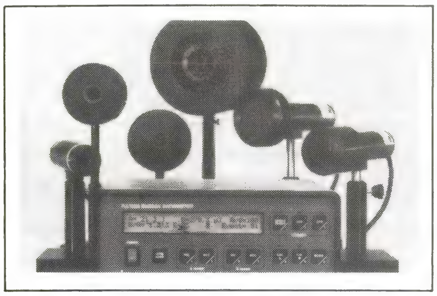
various character sizes and formats for the time/date display. You set the display to be either black or white, with or without a contrasting background, to ensure readability on all types of images. The instrument has battery backup for its real-time clock/calendar and its display format data. A switchable internal synch facility allows the instrument to operate as a stand-alone unit if required. The TDG-1 measures 280×50×254 mm (11×2×10 in.) and operates from 110/240V ac line supplies or a 12V dc supply. £450.

Wallington Instrument Co, Kimberley Pl, Purley, Surrey CR2 2BX, UK. Phone 01-668 4315.

Circle No 418



LASER-ENERGY METERS

- *Measure power of pulsed lasers*
- *Handle energy levels of 10^{12}J min*

The Rj-7600 Series laser-energy meters measure the output of pulsed-laser sources with energy levels of 10^{12}J min at pulse-repetition rates to 40 pps. The instruments can calculate the minimum, maximum, and standard deviations of sets of 10 or 100 pulses, and each can accommodate one of eight interchangeable pyroelectric, silicon, or thermopile probes. An IEEE-488 interface is optional. The dual-channel version of the instrument takes ratiometric measurements. Single-channel model, $3475; dual-channel model, $3850; 488 option, $550; probes, from $975 to $1500.

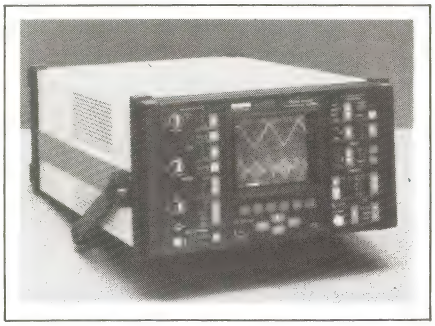
Laser Precision Corp, 1231 Hart St, Utica, NY 13502. Phone (315) 797-4449. TLX 646803.

Circle No 419

STORAGE SCOPE

- *Has a bandwidth of 100 MHz for repetitive signals*
- *Includes window triggering for glitch capture*

By random sampling at 40 MHz, the 5602 2-channel digital storage oscilloscope achieves a bandwidth for repetitive waveforms of 100 MHz. It



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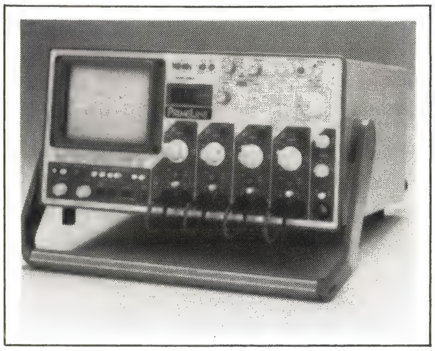
also has a 4-MHz-bandwidth real-time oscilloscope mode. The oscilloscope has 8-bit vertical resolution on its 10 mV/div (2 mV/div in expanded mode) to 5V/div input ranges, and has timebase ranges from 50 nsec/div (5 nsec/div with timebase expansion) to 20 sec/div. An autoset facility is provided for automatic selection of suitable input sensitivity and timebase ranges. You can display pretrigger traces on any timebase setting. The instrument can store as many as four pairs of traces (channel A and channel B) using 1k byte of trace memory per channel. Alternatively, you can reconfigure the trace memories to store one pair of traces at 4k bytes/channel or one trace at 8k bytes/channel. You can also store the corresponding instrument set-up with the traces. Trace annotation is provided on the CRT. On-screen measuring functions include absolute and relative voltage values, time from trigger point, time interval, frequency, and rise and fall times. Processing functions include averaging, smoothing, summing, multiplication, and trace expansion. The 5602 has both RS-232C and IEEE-488 interfaces for control and up/down loading of trace information. The oscilloscope also has analog and digital plotter outputs. Fr fr 64,000.

Enertec Instruments, 5 rue Daguerre, 42030 St Etienne Cedex 2, France. Phone 77252264. TLX 300796.

Circle No 420

POWER-LINE DISPLAY

- *Fully isolated inputs protected to 1 kV*
- *LEDs read out phase with 1° accuracy*



The 881 Powerscope II displays waveforms obtained from ac power systems, but can also be used as a general-purpose triggered scope. Four 25-MHz-bandwidth differential channels are isolated from each other and from the chassis and provide sensitivity from 20 mV/div to 200V/div. A fifth 50-MHz-bandwidth trigger-view channel is single ended. Any of the five channels can act as a trigger source. Channel 3 can measure instantaneous power by displaying a waveform proportional to the product of the waveforms on channels 1 and 2. An LED display indicates the phase differ-

The First

When you're looking for input on raster plotters, take a look at some major CalComp output. Twenty-four different versions from the fastest growing raster family in the world. (With more family members arriving soon.)

Every raster plotter incorporates more industry firsts, more choices. From simple, colorful business graphics to the complexity of super-dense integrated circuit design, mapping, etc.

The 5800 and 5700, our color and black-and-white electrostatic plotters, deliver speed, superior resolution, multiple configurations and A to E size plots.

For CAD graphics, PlotMaster™ produces quick-check "A" size presentation-quality color.

Or plug ColorMaster® into your PC and through **CalComp**atibility, you can run the most popular business presentation graphics software.

ColorMaster is a registered trademark of CalComp. © 1987 CALCOMP

ence between any two channels or between any channel and the ac line with an accuracy of 1° from 25 Hz to 2 kHz. $4995.

Primeline, Box 670, San Fernando, CA 91341. Phone (800) 525-5554; in CA, (818) 764-5400. TLX 4943094.

Circle No 421

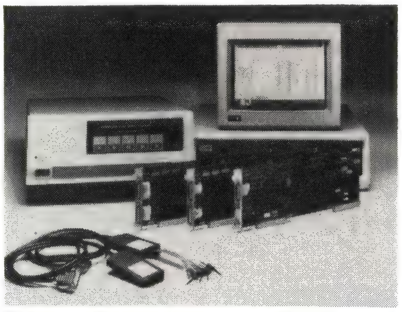
DIGITAL TESTER

- *Provides 336 inputs and 336 outputs*
- *Offers 20-MHz data rate*

The DSR10 high-performance digital word generation and recording device functionally tests µP boards, emulates system buses, and tests digital components and custom circuits. A Compaq DeskPro-386 personal computer performs computations, provides control, and supports the Microsoft Windows programming environment. During setup, you generate system-command sequences using a Windows-based pattern editor; you then merge them into TestBasic programs. You can loop a pattern indefinitely, or your program can specify the number of loops—as many as 64k—to be burst. Inputs and outputs can be backed by 16k-bit-deep, full-width, full-speed memory. You can place vectors with 10-nsec resolution. Three pod families provide compatibility with TTL, 5V HCMOS (high-speed CMOS), and ECL. An ASIC/PLD test fixture is also offered. System with one timing generator, two memory modules, three pods, and a blank test-head, $36,625; ASIC/PLD fixture, $995. Delivery, 60 days ARO.

Summation Inc, 11335 NE 122nd Way, Kirkland, WA 98034. Phone (206) 823-8688. TLX 152219.

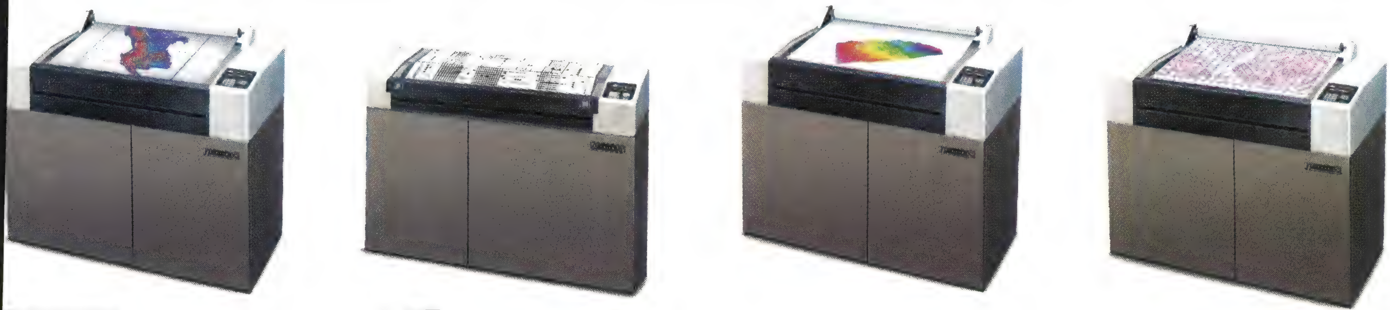
Circle No 422



RECORDERS

- *Plot traces of as many as 24 input channels*
- *Scan channels at 0.1, 0.2, or 0.5 readings/sec*

A 4- to 24-channel pen recorder comes in two versions: the HR-1100 panel/rackmount recorder and the HR-2100 flatbed recorder. The units have four pens of different colors that can plot continuous traces of as many as 24 input signals. The re-



Family.

The first family? You bet. First in high-resolution 400 DPI color. First in pin-point accuracy with electronic registration. First in embedded controllers to save space. First with convenient ROM pack firmware. First with flexibility of over 2,000 line and area fill colors. And too many more firsts to talk about here.

There's also a national 800 helpline, 425 trained service persons, 46 service centers nationwide, 32 international field offices, and on-site service. And a single supply source.

Don't be the last to learn about the first family. Call 1-800-CALCOMP or write CALCOMP, P.O. Box 3250, Anaheim, CA 92803. In Canada, call (416) 635-9010.

We draw on your imagination.™

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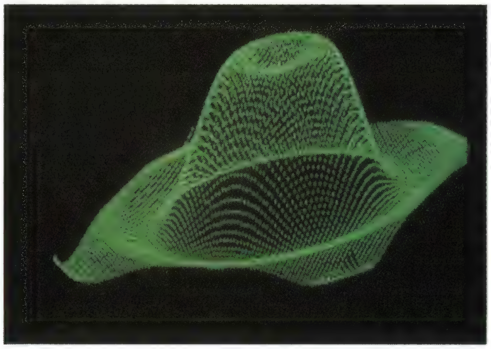
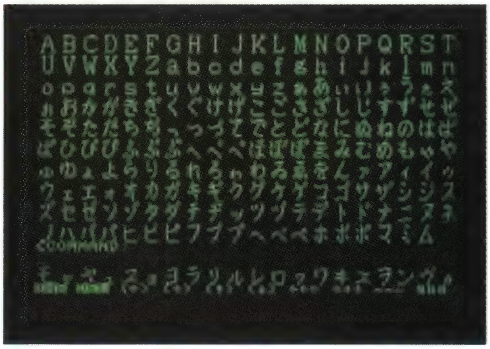
CIRCLE NO 53

VF Technology... The Bright Decision





Futaba, a world leading manufacturer of vacuum fluorescent displays, offers a wide assortment of *display tubes* in many sizes and formats. Also, Futaba offers *display modules* with all the electronics required to refresh the display and easily interface with the host system.

GRAPHIC DISPLAY

Both front glass phosphor, which provides maximum viewing angle and uniform surface appearance, and conventional back glass phosphor, with optimum brightness and software dimming capabilities, are available. All Futaba graphics modules offer complete drive electronics, bit mapped control with a DC/DC converter. All active components are surface mounted onto a single board.

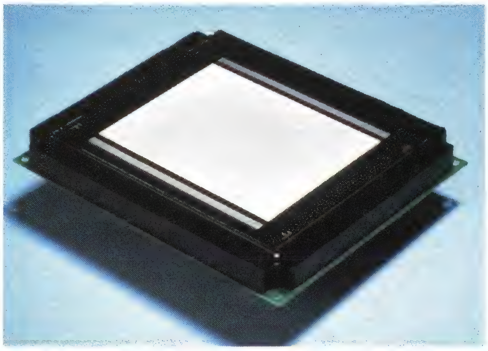
DOT MATRIX MODULES

Utilizing Futaba's dot matrix displays, a completely intelligent line of "dot modules" is available. Each includes all drive, power supply and microprocessor components surface mounted onto a single board. Surface mounted technology results in higher reliability and allows for a smaller overall package and lower cost. All dot modules require only a 5V DC power source and can accept parallel or 8 possible serial baud rates.

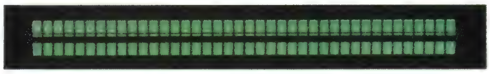
GRAPHIC DISPLAYS/MODULES

Futaba Display	Futaba Module	Pixels (Row X Char.)	Brightness (FT-L)	Module Dimensions (in.)
GP1005B	GP1005B03	128X64	400	7.28X3.35X1.77
GP1006B	GP1006B04	256X64	200	9.84X3.35X1.77
GP1009B	GP1009B03	240X64	200	6.2X2.76X1.57
GP1010B	GP1010B01	176X16	200	7.32X2.16X1.70
GP1002C	GP1002C02	320X240	100*	7.10X6.30X1.60
GP1004B	GP1004B03	640X400	30	9.65X7.28X1.85

***Different Versions Available**



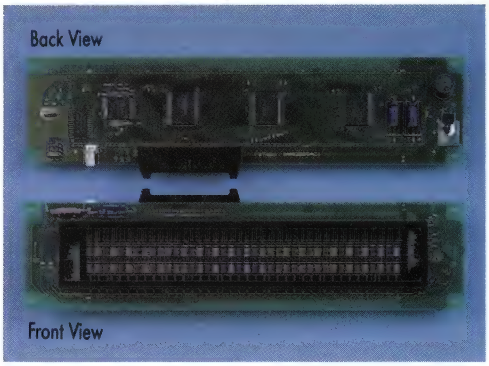
Compact, flat panel graphic displays and modules present clean, sharp images, whether for text or full graphics application.



2 x 40 character (display)

DOT MATRIX DISPLAYS/MODULES

Futaba Display	Futaba Module	Char. X Row	Dot Format	Char. Ht. (in.)	Module Dimensions (in.)
20SD01Z	M20SD01	20X1	5X7	0.200	6.3X1.97X.75
20SD42Z	M20SD42	20X1	5X12	0.344	7.1X2.16X.88
40SD02Z	M40SD02	40X1	5X7	0.200	9.45X2.16X.88
40SD42Z	M40SD42	40X1	5X12	0.344	9.45X2.16X.88
202SD03Z	M202SD03	20X2	5X7	0.200	6.7X2.56X.90
402SD04Z	M402SD04	40X2	5X7	0.200	10.43X2.56X.90
MANY OTHER DISPLAYS	**NEW MODULES AVAILABLE SOON**				



2 x 40 character (module)

Pattern flexibility and pleasing appearance are offered by Futaba in dot displays and modules.

Futaba also offers a complete catalog of alphanumeric, segmented displays.

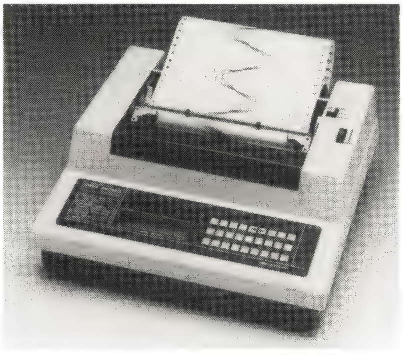
Futaba supports its products with design engineering and system integration assistance. Call or write today.

FUTABA
Corporation of America
Electronic Components Division

711 E. State Parkway
Schaumburg, IL 60173

Telephone: (312) 884-1612
or (312) 884-1444

CIRCLE NO 222



corders handle straight dc voltages as well as seven thermocouple types and RTDs. The low-frequency recorders scan each input channel at 0.1, 0.2, or 0.5 readings/sec. You can also annotate the charts. A transient-capture option has a 20-kHz bandwidth and digitizes signals at 10-bit resolution into a 2k-sample memory. $4250.

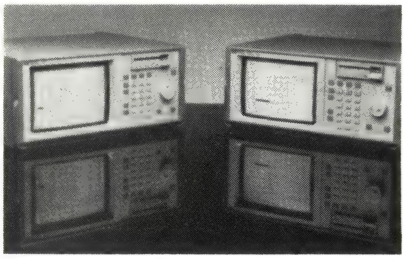
Primeline, Box 670, San Fernando, CA 91341. Phone (800) 525-5554; in CA, (818) 764-5400. TLX 4943094.

Circle No 423

LOGIC ANALYZERS

- *Have 25-MHz state or 100-MHz transitional timing*
- *Come in 80- and 32-channel models*

The 80-channel HP 1650A and the 32-channel HP 1651A logic analyzers both use pop-up menus for control, and each has a 3½-in. disk drive. You can split either analyzer into two independent sections to capture nonsynchronized activity. The first instrument can have either 25-MHz state timing or 100-MHz transitional timing on its 80 channels. It has five clock inputs and four qualifiers. Its trigger circuitry has eight word recognizers and one range recognizer; the trigger sequence is eight levels deep max. To help identify linkages in software, this analyzer can store two states prior to a trigger event. Each analyzer weighs 22 lbs. 1650A, $7800; HP 1651A, $3900.



Hewlett-Packard Co, Inquiries Manager, 1820 Embarcadero Rd, Palo Alto, CA 94303. Call local office.

Circle No 424

PROTOCOL ANALYZER

- *Supports common local- and wide-area protocols to 72k bps*
- *Has hard- and floppy-disk drives and GPIB port*

The HP 4954A protocol analyzer monitors, analyzes, and simulates network data traffic. It supports BSC, SNA/SDLC, HDLC, X.21,

Now with zero wait-states at 20 MHz

Race Card

The HK68/V2F is a high-performance VME microcomputer with race-bred 32-bit power for real-time applications.

High engine output and economical, dependable performance are just the start of the HK68/V2F's standard equipment:

▪ Up to 25MHz Motorola 68020 CPU ▪ Up to 4MB of on-board DRAM with parity ▪ 128K EPROM ▪ Serial Port ▪ Mailbox interrupt support ▪ VSB compatible memory expansion bus

Optional racing equipment includes 68881 Floating Point Coprocessor and no wait-state DRAM.

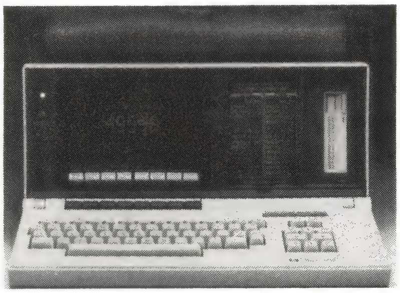
HEURIKON CORP.

Take Heurikon's HK68/V2F for a test-lap today.
Call toll-free: 1-800-356-9602 (ext. 912).

3201 Latham Drive ▪ Madison, WI 53713

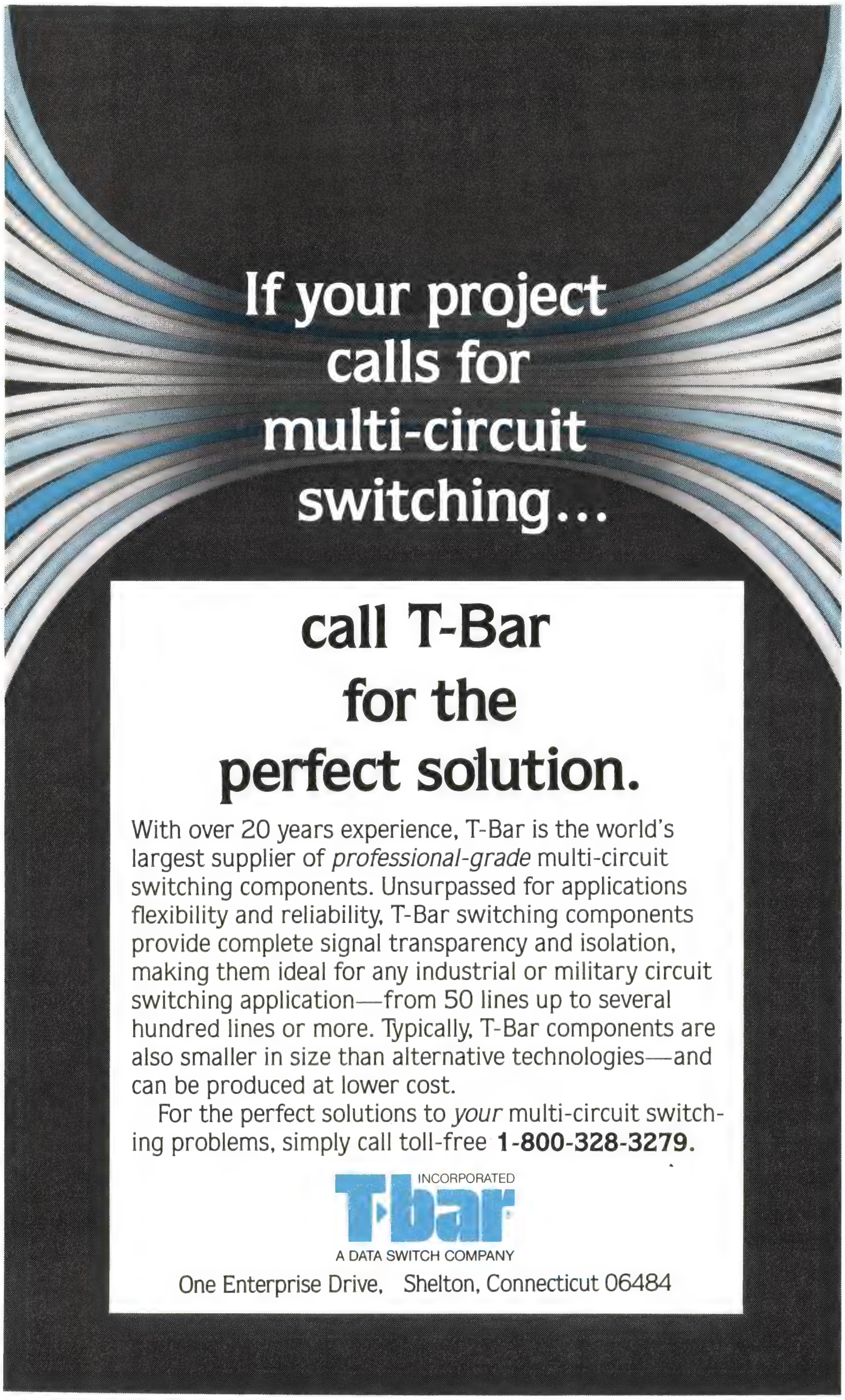
CIRCLE NO 54

X.75, and DDCMP protocols and can act as an X.25 performance analyzer or as an SNA, X.21, or CCITT#7 development tool. It includes a 20M-byte hard-disk drive, 3½-in. floppy-disk drive, and GPIB port, and has standard test routines for common protocols so that you can check new designs for compliance to standards. $17,000. Delivery, eight weeks ARO.



Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 425



If your project calls for multi-circuit switching...

call T-Bar for the perfect solution.

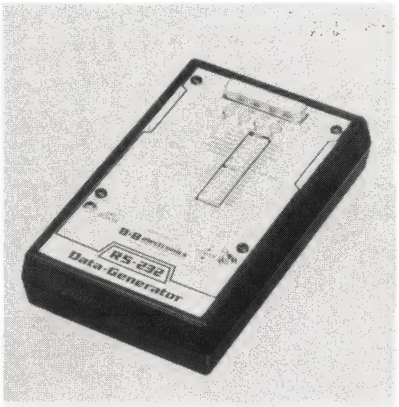
With over 20 years experience, T-Bar is the world's largest supplier of *professional-grade* multi-circuit switching components. Unsurpassed for applications flexibility and reliability, T-Bar switching components provide complete signal transparency and isolation, making them ideal for any industrial or military circuit switching application—from 50 lines up to several hundred lines or more. Typically, T-Bar components are also smaller in size than alternative technologies—and can be produced at lower cost.

For the perfect solutions to *your* multi-circuit switching problems, simply call toll-free **1-800-328-3279.**

T-bar INCORPORATED
A DATA SWITCH COMPANY

One Enterprise Drive, Shelton, Connecticut 06484

CIRCLE NO 55



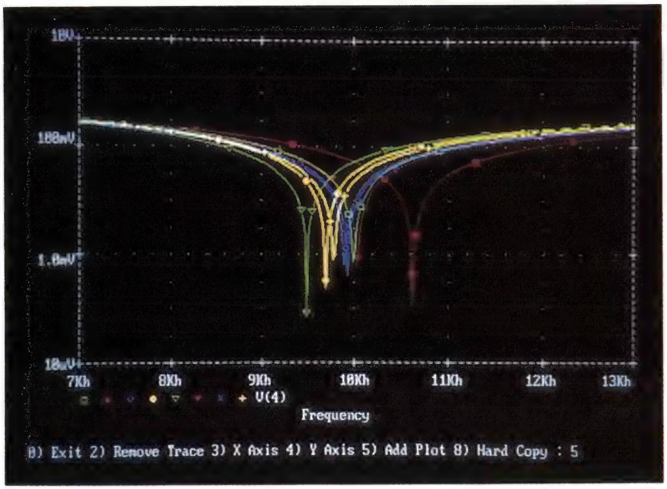
DATA GENERATOR

- *Generates ASCII data in user-selectable formats*
- *Powered from built-in battery or optional external supply*

The 232DG data generator provides serial ASCII data in several combinations of line length, baud rate, parity, number of stop bits, and word length. The output data flow can be controlled with the DTR (data terminal ready) or RTS (request to send) lines or by sending the X-on or X-off characters. You can use switches to control the sense of CTS (clear to send), DSR (data set ready), and CD (carrier detect) and to determine whether data comes out on TXD (transmitted data) and RXD (received data). By having the unit continuously output the letter "U", you make it generate a square wave at one-half the selected baud rate for a worst-case test. An internal 2716 EPROM generates the character set—all 96 printable ASCII characters. You can reprogram it to produce custom test patterns. $199.95; ac power supply, $14.95.

B & B Electronics Mfg Co, Box 1040, Ottawa, IL 61340. Phone (815) 434-0846.

Circle No 426



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0) Exit 2) Remove Trace 3) X Axis 4) Y Axis 5) Add Plot 8) Hard Copy : 5
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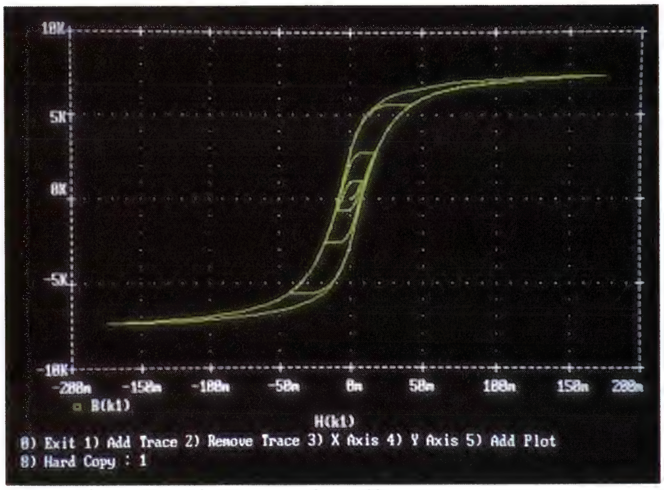
Monte Carlo analysis of a notch filter



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0) Exit 1) Add Trace 2) Remove Trace 3) X Axis 4) Y Axis 5) Add Plot
8) Hard Copy : 1
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B-H curve from a core in the PSpice transformer library

PSpice

The Standard for Analog Circuit Simulation

Since its introduction just over three years ago, MicroSim's PSpice has sold more copies than all other SPICE-type simulators combined. Why do so many engineers choose PSpice? *Perhaps because every copy of PSpice includes these features:*

- Standard, non-encrypted, parts libraries for diodes, bipolar transistors, power MOSFET's, opamps, voltage comparators, and transformer cores.
- GaAs MESFET devices.
- Non-linear transformer devices modeling saturation, hysteresis, and eddy current losses.
- Ideal switches for use with, for example, power supply and switched capacitor circuit designs.

Or perhaps because of these innovative options available for PSpice:

- Monte Carlo analysis to calculate the effect of parameter tolerances on circuit performance.
- The Probe "software oscilloscope", allowing interactive viewing of simulation results. The photographs above are Probe displays.
- The Parts parameter extraction program, allowing you to extract a device's model parameters from data sheet information.
- The Digital Files interface, allowing you to transfer data from your logic simulator to (or from) PSpice. The interface performs the necessary D to A or A to D conversions.

Or perhaps because PSpice is available on these computers:

- The IBM PC family, including the new PS/2 and the COMPAQ 386.
- The Sun 3 workstation.
- The VAX/VMS family, including the Micro VAX II.

Or perhaps it is our extensive product support. Our technical staff has over 50 years of experience in CAD/CAE and our software is supported by the engineers who wrote it. With PSpice, expert assistance is only a phone call away.

If for any of these reasons PSpice interests you, please call or write today for a free demo copy of PSpice. Find out for yourself why PSpice is the standard in analog circuit simulation.

MicroSim Corporation

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Laguna Hills, CA 92653 (714) 770-3022
(800) 826-8603 • Telex 265154 SPICE UR

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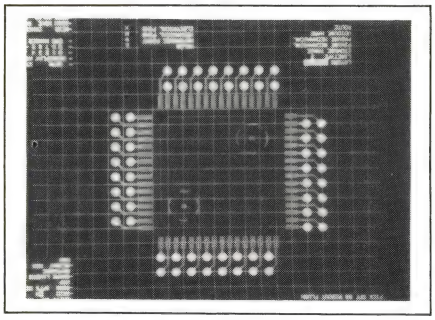
CIRCLE NO 224

NEW PRODUCTS

CAE & SOFTWARE DEVELOPMENT TOOLS



SHAPE LIBRARY

- *Lets you define, edit, and store custom shapes for SMDs*
- *Lets you mirror a shape for placement on back of board*

The Surface Intelligent Shapes (SIS) library for the Scicards CAE system lets you define, edit, and store an unlimited number of customized design geometries for surface-mount devices. When you create a new shape, you can include complete placement, routing, and assembly information; you can add etching instructions to the shape definition to facilitate the routing of complex body shapes. You can also set void areas for traces and vias. A menu system guides you through the levels of commands, prompts you to supply necessary data, and warns you of syntax errors. A graphics advisory tracks the shape-definition status and prioritizes commands during the creation of complex body shapes. You can define a shape by layers; the mapping protocol builds the shapes from the top down for standard pc boards and from the bottom up for hybrid designs. The Scicards system can place as many as 2500 components on each side of the substrate and can use the same SIS library definition for both sides by automatically inverting the original shape. The SIS Library is an enhancement of the Scicards CAE system and is included in the $25,000 price of a new system; if you already own the system, you can obtain the SIS Library at no extra charge.

Scientific Calculations Inc, Box H, Fishers, NY 14453. Phone (716) 924-9303.

Circle No 427

CODE-GENERATOR LINK

- *Connects Excelerator CASE tool to Telon code generator*
- *Provides Telon's specialized symbols*

XL/Interface Telon allows the screen and report designs that you generate with the vendor's Excelerator CASE tool to be passed to the Telon code generator from Pansophic Systems Inc (Oak Brook, IL). The Telon code generator, which runs on mainframes and IBM PCs and compatibles and which can generate Cobol or PL/1 code, is particularly suited to developing on-line information systems that incorporate multiple screens and reports. The vendor's link enhances Excelerator, allowing you to generate the specialized graphs and dictionary entities (circle flow graphs) that depict Telon applications and to translate files in Excelerator format to files in Telon format. Pansophic Systems' software lets you import the converted files into either the mainframe or the PC version of Telon for code generation. A corporate license for XL/Interface Telon, which permits its use throughout an organization, costs $9000.

Index Technology Corp, 1 Main St, Cambridge, MA 02142. Phone (617) 491-2100. TWX 910-380-7014.

Circle No 428

FORMAT CONVERTER

- *Transforms data from 5¼-in. to 3½-in. disk format*
- *Lets you transfer data from IBM PCs to PS/2 machines*

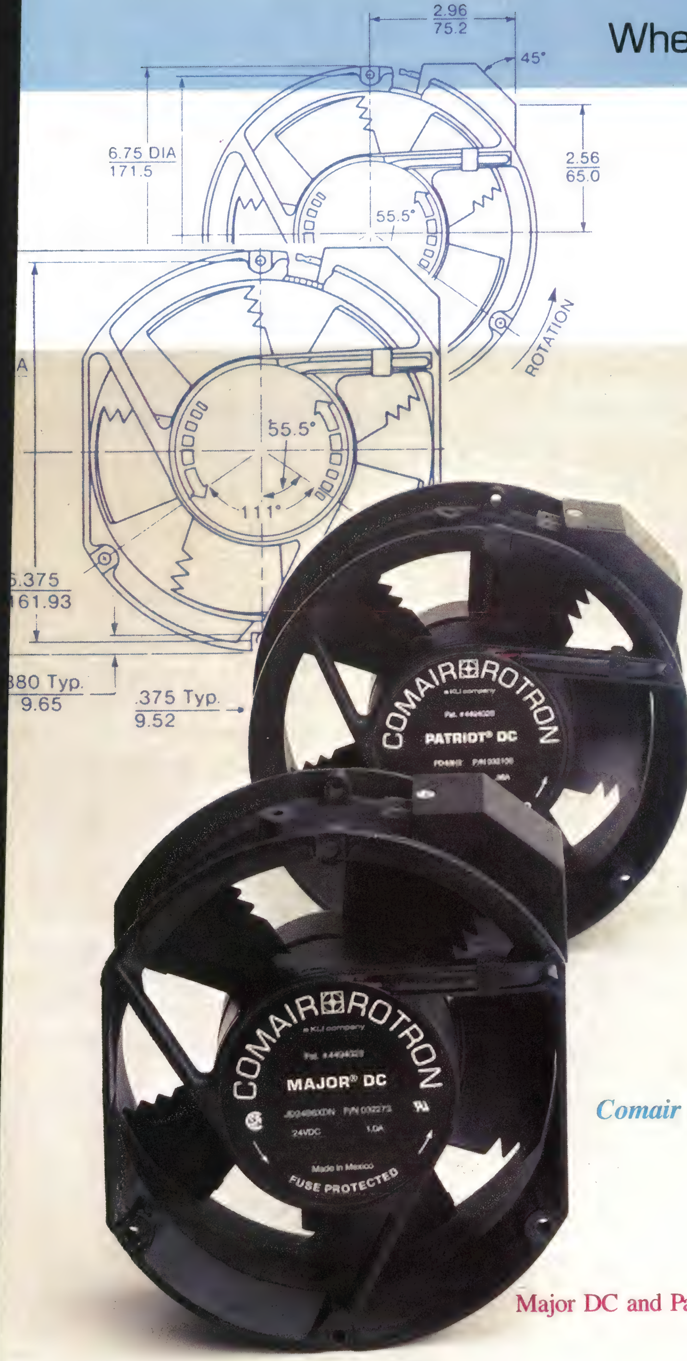
The Interchange package comprises software supplied on a 5¼-in. diskette, software supplied on a 3½-in. diskette, and a cable. The cable links the parallel ports of two IBM PC family or compatible computers, one of which uses the 5¼-in. format and the other of which uses the 3½-in. format. The software then provides high-speed data transfer in either direction. $39.95.

SMT Inc, 1145 Linda Vista Dr, San Marcos, CA 92069. Phone (800) 648-6262; in CA, (619) 744-3590.

Circle No 429

performance

Where Innovation Meets Reliability



Comair Rotron's line of commercial air-movers are internationally respected because they do what they are designed to do . . . day in and day out.

Comair Rotron airmovers live up to your design expectations in everything from sophisticated mainframe computers to complex telecommunications systems.

Our engineering achievements are symbols for innovation and reliability. Nowhere is this professionalism more evident than in the popular high flow versatility of the Patriot and Major brushless DC tubeaxial fan. As the first domestic manufacturer of industrial six inch fans, Comair Rotron offers wide voltage input and performance ranges with Patriot DC and Major DC. In addition, Fan Performance Sensors (a Comair Rotron first) are available in both models . . . as are current limiting features.

Manufactured by Comair Rotron, the patented feather edge offers an acoustically quiet, ball bearing airmover able to satisfy your most demanding requirements.

Comair Rotron. The first name in forced convection cooling technology.

Major DC and Patriot DC Fans

UL recognized and CSA certified.

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CIRCLE NO 225

8051 DEVELOPMENT

- *Software development station provides CPU*
- *Offers 8051 assembler, disassembler, symbolic debugger*

The AMS 51 development station and target system permits you to develop software for the 8051 microcontroller family. The built-in RS-232C serial port operates at standard data rates from 300 to 9600 bps and lets you use any personal computer as a file server for source-code, Intel-Hex, or listing files. The resident 8051 assembler accepts standard Intel 8051 mnemonics and generates object code in Intel-Hex format. The hardware provides 22 bidirectional digital I/O lines and eight high-current output lines for control applications. An expansion bus lets you interface to external equipment. Debugging features allow you to set as many as five breakpoints and to execute a user program either as a stand-alone program or subroutine. Power consumption is 120 mA at 9V from a wall adapter. $1595.

Advanced Micro Solutions, 1033 S Imperial Dr, Hartland, WI 53029. Phone (414) 367-3577.

Circle No 430

3-D MODELING SOFTWARE

- *Lets you construct 3-D models in a wireframe display*
- *Has hidden-line removal and rendering with point light source*

Generic 3-D is a polygon-based 3-D solid-modeling program with a wireframe display. It features a 3-D cursor, and it has perspective, extrusion, isometric-view, construction-plane, multiple-window, automatic-sectioning, interference-checking, object- or group-duplication, and surfaces-of-revolution features. You can use the program as a stand-alone package, or you can transfer your models to Generic CADD and other of the vendor's products. Also available is the add-on 3-D Rendering Module, which defines a solid object by means of its boundaries—faces, vertices, and edges. Generic 3-D, $199.95; 3-D Rendering Module, $149.95.

Generic Software Inc, 8763 148th Ave NE, Redmond, WA 98052. Phone (206) 885-5307.

Circle No 431

RF FILTER DESIGNER

- *Analyzes and synthesizes lumped-element filters*
- *Lets you synthesize as many as 30 sections*

LEFLTR performs analysis and synthesis of lumped-element filters for AM/FM, IF baseband, and broadband applications. You can use

SUPPLYING MOBILE ELECTRONICS IS NO LONGER A QUESTION OF SOURCE VOLTAGE

There's only one DC/DC converter covering the whole range of source voltages available on airplanes, boats, trucks and many other transport vehicles!

DC/DC Converters Series A/B/CM and B/CSR

- Input range 7 to 140 VDC for 12, 24, 36, 48, 60, 72 and 110V-batteries covered by one single module
- Input transient protection
- Very low RFI level; A/B, VDE 0871
- Isolation 2.5kV$_{eff}$
- High efficiency, up to 84%
- Up to 3 outputs with 20 to 50 W
- T$_A$–40 to + 70°C without derating
- Rugged and compact design in 6-side shielded aluminum case
- MTBF 120,000 hrs at T$_A$ 40°C

Identical units with 88 to 372 VDC and 90 to 264 VAC inputs available.

SUPPLYING GREAT PERFORMANCE:

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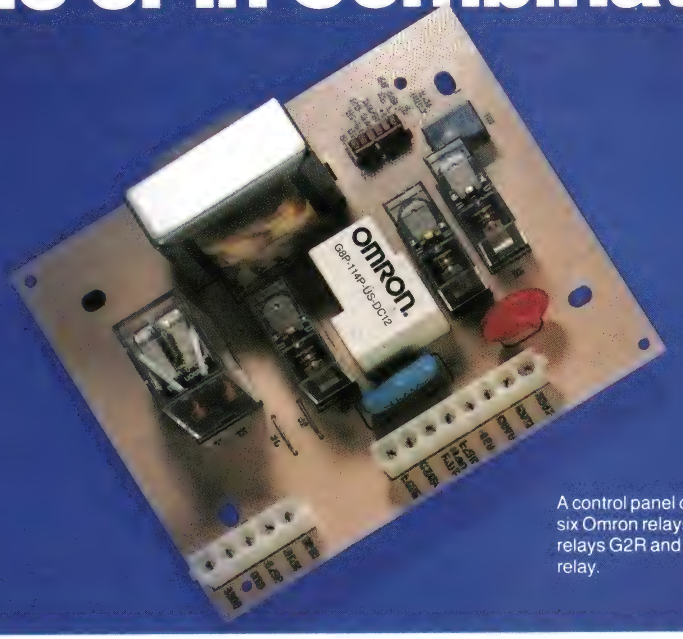
MELCHER AG, CH-8610 Uster/Switzerland, Ackerstr. 56, Tel. 01-941 37 37
MELCHER INC., Natick, MA 01760, 10 Cochituate Str., Tel. 617 653 9979

b6us

CIRCLE NO 56

Omron Relays Respond-Alone or in Combination



A control panel of a major appliance manufacturer shows six Omron relays—a general purpose LY2, power PCB relays G2R and G8P, as well as a G6E signal control relay.

Omron Has Your Relay

From industry standard general purpose relays to power PC board relays, Omron relays provide low power consumption, high speed operation and high reliability to meet your application needs. In addition to your standard relay requirements, Omron relays offer a wide variety of options, including LED indicators, push-to-test buttons, high switching capacity, and more.

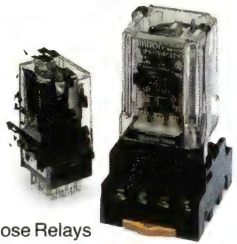
Designed To Meet Customer Needs

Because there are as many application requirements as there are design engineers, Omron backs up its extensive relay line with a commitment to product innovation. Many of our best-selling standard relays were initially developed to meet specific customer requirements in a wide variety of industry applications.

In Stock Where You Need Them

Count on your local Omron stocking distributor for assistance and off-the-shelf delivery of Omron switches and relays. Our commitment to customer service has forged one of the strongest distributor networks in the industry. But don't just take our word for it. Contact Omron for more information and a distributor list today.

1-800-62-OMRON



Omron General Purpose Relays include our MY, MK, LY and MJ models.

Shown here are key specifications for some of Omron's most popular power and general purpose relays.

Power Relays

Model	G2R		G4W		G4B	G5D		G8P		
Contact Form	1A, 1C	2A, 2C	1A	2A	1A, 1B, 1C	1X	2X	1A	1B	1C
Rated Load	10A, 250VAC/30VDC High Capacity Type 16A, 250VAC/30VDC	5A, 250VAC/30VDC	15A, 230VAC/24VDC	10A, 220VAC/24VDC	25A, 220VAC/24VDC	30A, 250VAC	20A, 250VAC	30A, 250VAC 20A, 28VDC	15A, 250VAC 10A, 28VDC	20A/10A*, 250VAC/28VDC
Terminal Types	PCB, QC, Solder		PCB, QC, Solder, QC and PCB		QC, QC and PCB (coil)	QC		PCB		
Coil Types	AC/DC		DC		AC/DC	AC/DC		DC		
Coil Power	AC: 0.9 VA DC: 0.53 W		0.8 W		AC: 1.3 VA DC: 1.2 W	AC: 3.0 VA DC: 1.9 W		0.9 W		
Approved Standards	UL, CSA, TUV, VDE, SEV, SEMKO		UL, CSA, VDE, SEV, SEMKO		UL, CSA	UL, CSA, VDE, TUV		UL, CSA		

General Purpose Relays

Model	MK			MY			LY				MJ		
Contact Form	1C	2C	3C	2C	3C	4C	1C	2C	3C	4C	1C	2C	3C
Rated Load	5A/220 VAC 3A/24 VDC		3A/220 VAC 2A/24 VDC	5A/220 VAC 5A/24 VDC		3A/220 VAC 3A/24 VDC	15A/110 VAC 15A/24 VDC	10A/110VAC 10A/24VDC			10A/110VAC 10A/24VDC		
	High Capacity Type 10A/230 VAC 10A/28 VDC			High Capacity Type 5A/240 VAC 5A/28 VDC									
Terminal Types	Octal Pin			PCB or Solder/Plug-in			PCB or Solder/Plug-in				QC or Plug-in		
Coil Types	AC/DC			AC/DC			AC/DC				AC/DC		
Coil Power	2.1 VA 1.2 W			1.2 VA 0.9 W			1.2 VA 0.9 W		2.0 VA 1.4 W	2.5 VA 1.5 W	2.1 VA 1.2 W		2.5 VA 1.2 W
Approved Standards	UL, CSA, LR			UL, CSA, SEV, LR			UL, CSA, VDE, SEV, LR				UL, CSA		

*No/NC contacts

Responsive Innovation

OMRON ELECTRONICS, INC.
One East Commerce Drive
Schaumburg, IL 60173
TWX 910-291-0426

the program to synthesize lowpass, highpass, bandpass, or bandstop filters with either Chebyshev or Butterworth response and with as many as 30 sections. You specify filter impedance, source impedance, load impedance, and other parameters; the program calculates input VSWR, time delay, insertion loss, through-path phase, and input impedance, and it specifies component values. You can analyze the performance of either the standard circuit or the dual of the standard circuit with respect to frequency. The menu-driven interface makes it easy to select the appropriate mode and to enter the required parameters; errors generate explicit messages that aid in recovery; and the program provides default values for most design calculations. The program runs on any IBM PC or compatible computer. $495.

Microwave Software Applications Inc, Box 1736, Norcross, GA 30091. Phone (404) 441-9193.

Circle No 432

CP/M WORD PROCESSOR

- *Provides programmable macros*
- *Has an "Undo" command*

WordStar, CP/M Edition, Release 4 provides more than 100 enhancements, including a new indexing system and improved versions of MailMerge and the Word Plus spelling checker. Other enhancements are a "Go to page" command, an "Undo" command, programmable macros, the ability to follow a drive/user-number path, and if your hardware permits, the capacity to employ definable function keys and to display boldface and underlining on screen. Operations speed has also been improved. You can use the new release with both floppy- and hard-disk systems and can configure it for output to laser printers. $295; updates, $89.

MicroPro International Corp, 33 San Pablo Ave, San Rafael, CA 94903. Phone (415) 499-1200. TWX 650-263-0157.

Circle No 433

AI SOFTWARE TOOL

- *Organizes and processes knowledge in four ways*
- *Runs on IBM PC/XT, PC/AT, and compatibles*

KnowledgePro is an artificial-intelligence software-development system that offers several ways of processing and organizing knowledge. You can create topics, which organize information as conceptual units with hierarchical structures. Each topic has a name, description, and contents, and each performs some action. Predefined topics act like built-in topics, and user-written

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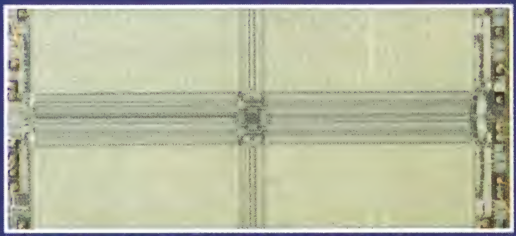
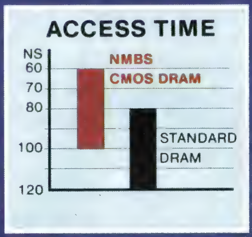

The Product: Die Size 52Kmil²

The Package

The Production



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CIRCLE NO 227

topics behave like system commands. You can use hypertext organization to highlight certain words or concepts in a screen of text; by pressing a function key, you can follow a highlighted thread, or train of thought, to other screens that also have highlighted words. When you design a system, you can cause highlighted words to actuate any set of instructions or area of the knowledge base. You can also use IF . . . THEN rules, which are the basis of current expert-system technology. The package's built-in list-processing facilities permit you to manipulate words or lists of words, change window colors, perform calculations, and access external files. The program requires a PC/XT, PC/AT, or compatible computer with at least 512k bytes of RAM. $495.

Knowledge Garden Inc, 473A Malden Bridge Rd, Nassau, NY 12123. Phone (518) 766-3000.

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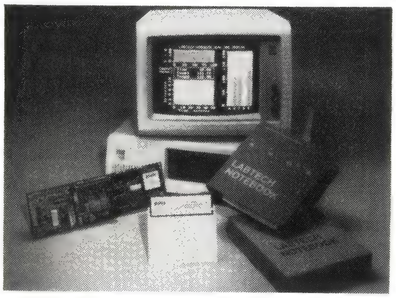

REAL-TIME ANALYSIS

- *Lets analysis programs acquire real-time data*
- *Provides three modes for reading acquired data*

Labtech Notebook, which can gather real-time data in background mode while an application program runs in foreground mode, can now also communicate with foreground application programs through Labtech Real-Time Access. The access package creates a virtual data-acquisition and process-control device that emulates a standard file or I/O device. Thus, the foreground application can write a command stream that either modifies Labtech Notebook's acquisition and control parameters or sends data directly to an instrument. Likewise, the application program can use its own commands to read data from the virtual device in one of three modes. In the first mode, it reads all data accumulated in the buffer since the last read request; in the second, it reads only the latest data point in the buffer; and in the third, it collects and reads a new data point immediately. You can also set the read request to return with no data if none has been acquired since the last read request, or you can instruct it to wait until the acquisition module places new data in the buffer. The access package runs on any

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CIRCLE NO 228

IBM PC, PC/XT, PC/AT, or compatible computer that has 384k bytes of RAM beyond the application program's memory requirements, and two 360k-byte floppy-disk drives (however, a hard disk will give better results). You also need PC-DOS version 3.1 or higher and Labtech Notebook version 3.0 or higher. $295.

Burr-Brown, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TLX 666491. TWX 910-952-1111.

Circle No 435

REAL-TIME KERNEL

- *Provides for fast response to interrupts*
- *Lets an 80386 perform multitasking in protected mode*

The iRMK is a 32-bit, real-time, multitasking operating-system kernel for use in 80386-based systems. The kernel and its applications operate in the 80386 protected mode, on a single privilege level, and in a memory space as large as 4G bytes. The kernel provides operating-system features and services such as task management, interrupt management, time management, device management, mailboxes and semaphores, and memory-pool management that provides both fixed- and variable-block allocation. Two optional modules allow applications to make full use of the Multibus II architecture: The first implements message passing by means of the Multibus II transport protocol, and the second gives access to the interconnect space. These modules let you distribute an application among several processors. The kernel size can vary from 8k bytes for a minimal system to 33k bytes for a system that uses all the optional modules. In embedded control applications, the kernel can reside in PROM or EPROM. The kernel's interrupt latency is 5.4 μsec min, 10 μsec avg, and 50 μsec max. Single-processor license, $1500.

Intel Corp, Box 58065, Santa Clara, CA 95052. Phone (800) 548-4725.

Circle No 436

MATH TOOL

- *Provides built-in simultaneous equation solver*
- *Lets you use LIM expanded memory protocol*

Version 2.0 of MathCAD is an upgrade of this interactive calculation software package for IBM PCs and compatibles. Among the new computational features are a built-in simultaneous equation solver and matrix capabilities, which include addition, multiplication, scalar multiplication, dot-product functions, and inversion, transposition, and determinant operations. The pro-

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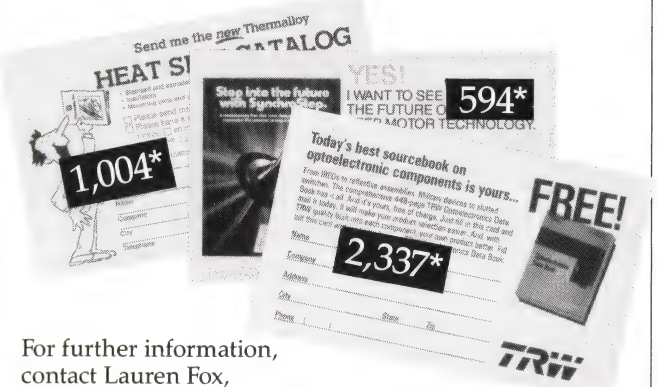

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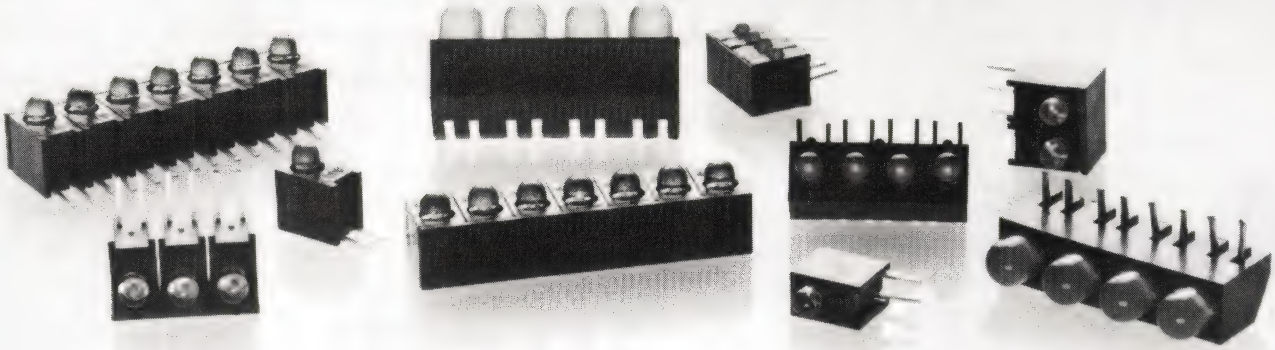

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CIRCLE NO 229

gram's more efficient RAM storage and other enhancements speed up most calculations by two to four times and yield faster scrolling and screen redrawing. In addition, the upgrade's ability to make use of the Lotus/Intel/Microsoft expanded-memory facilities allows you to build larger documents than before. The program's other new features include plot autoscaling; a configuration file that lets you set the defaults for plotting and hard-copy parameters; and support for more printers, plotters, and high-resolution monitors. $349.

MathSoft Inc, 1 Kendall Square, Cambridge, MA 02139. Phone (617) 577-1017.

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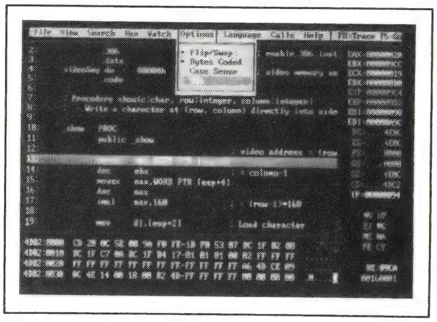
PARSER

- *Generates language translators in C or Pascal*
- *Automatically constructs syntax trees*

QParser+ is an enhanced version of a productivity tool for the development of computer languages and language translators such as compilers, assemblers, interpreters, and complex user interfaces. The program can construct a syntax checker, written in either C or Pascal, that is based solely on a set of syntax rules that define the language. It automatically places the verified input-language elements in a syntax tree; you can then easily write a recursive tree-walker that will walk through all the tree's leaves and generate code in the target language. A sample tree-walker comes with the program. The manual provides several sample translators (including a compiler, an assembler, an interactive calculator, and a simulator) that help you understand the principles of translation. PC-DOS version, $475; VAX site license, $2000.

QCAD Systems Inc, 1164 Hyde Ave, San Jose, CA 95129. Phone (408) 995-6884.

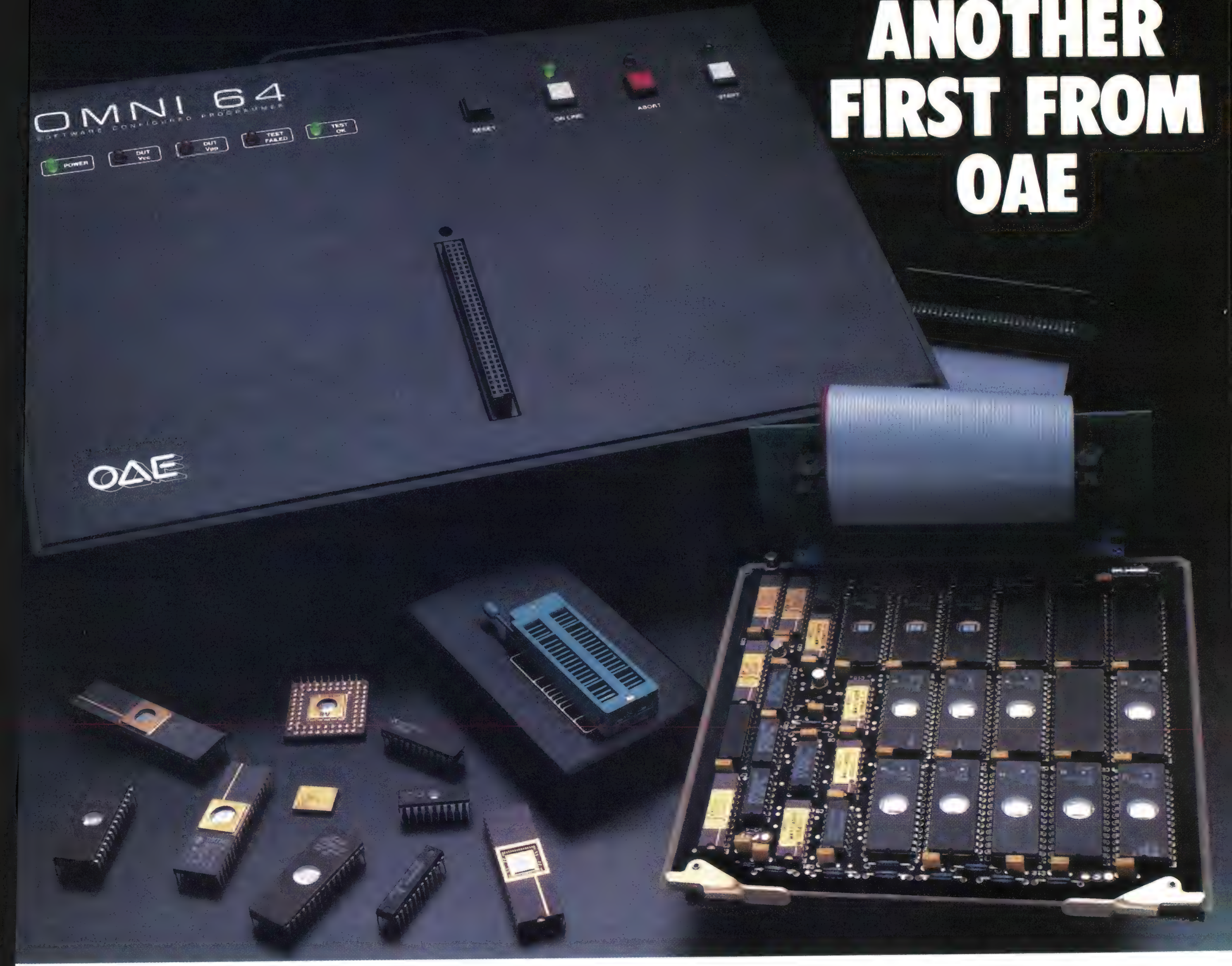
Circle No 438



80386 MACROASSEMBLER

- *Lets you program for the 80387 numeric coprocessor*
- *Has source-level debugger that provides multiple windows*

Macro Assembler version 5.0 has enhancements that allow you to program the 80386 µP and 80387 nu-



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Glendale, CA 91203
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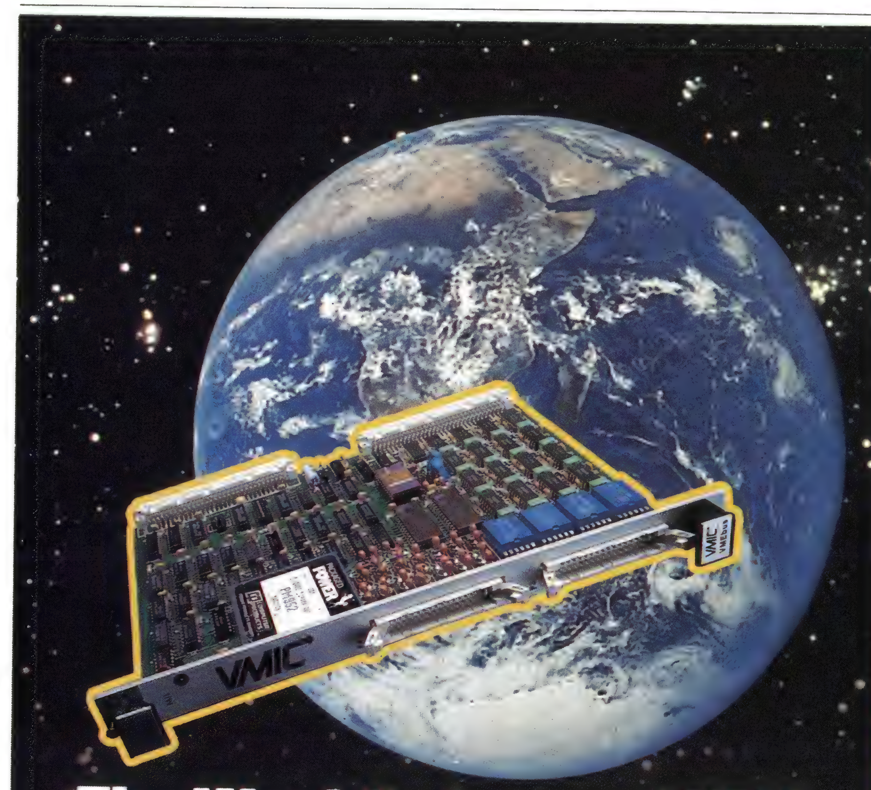
(800) 828-0080 or
(800) 423-8874 in California.
TWX (510) 600-8099

meric coprocessor. According to the vendor, this version runs 25 to 40% faster than previous versions. It features a new set of segment directives that reduces the amount of time you have to spend on segment setup, and it has completely new documentation, which includes a mixed-language programming guide. DOS-interface macros make it easier to request operating-system services, and command-line options allow you to set "define" symbols and warning levels on the command line. The package includes a multiwindow source-level debugger, a library manager, an overlay linker that runs twice as fast as its predecessor, and other utilities that simplify assembly-language program development. In order to run the macroassembler, you'll need DOS 2.0 or higher and an IBM PC or compatible with at least 256k bytes of RAM and two double-sided floppy-disk drives or a hard disk. $150.

Microsoft Corp, Box 97107, Redmond, WA 98073. Phone (206) 882-8080. TLX 328945.

Circle No 439



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The CAE/CAD Buyer's Guide consists of an interactive decision-support program, a videocassette on product evaluation, and a check list. The software allows you to enter specifications for each product under evaluation and to give each specification a weight that represents its importance in relation to your needs. The program subsequently analyzes your weighting and recommends the products that most closely match your needs. The program comes with specification entries for all the vendor's CAE/CAD products, and it also has a template that helps you enter other vendors' product specifications. The package includes a tutorial and provides on-line, context-sensitive help. $99.

Aptos Systems, 10 Victor Square, Suite 200, Scotts Valley, CA 95066. Phone (408) 438-2199. TLX 3710387.

Circle No 440

CAE SOFTWARE

- *Schematic-drawing package has new library for ladder diagrams*
- *Autorouter added to pc-board design module*

Hiwire is a schematic drawing package that runs on the IBM PC and compatibles. Enhancements include two libraries for ECL components

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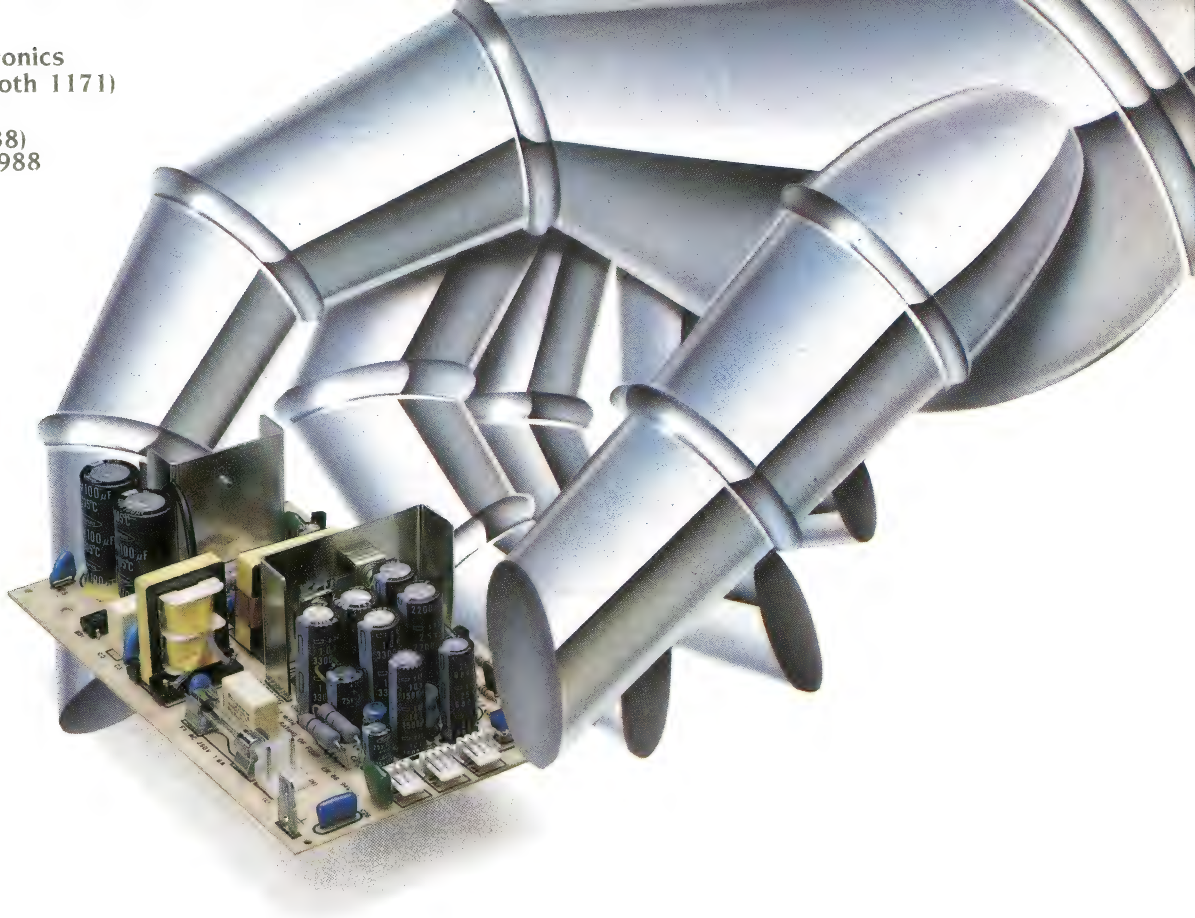

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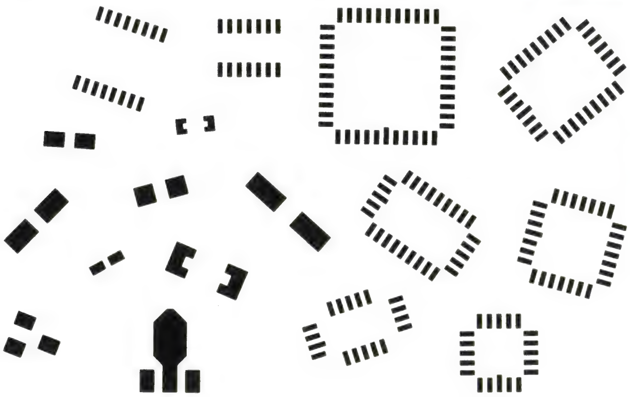

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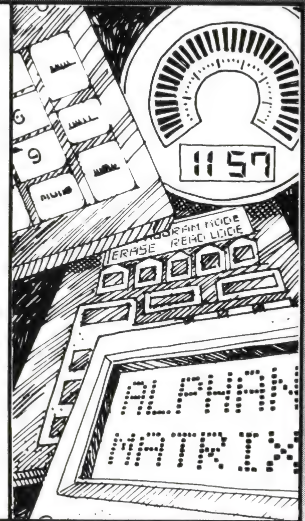

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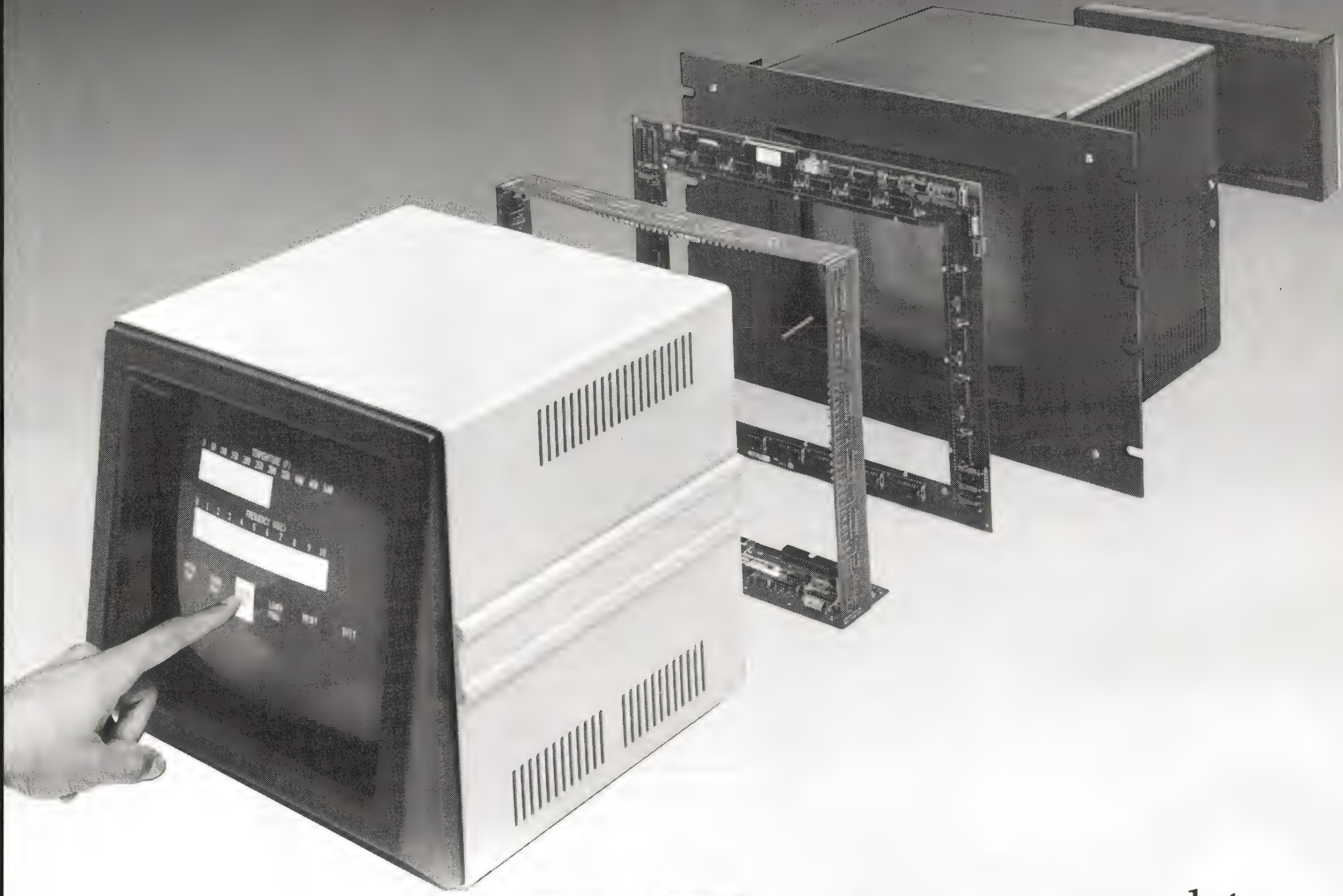

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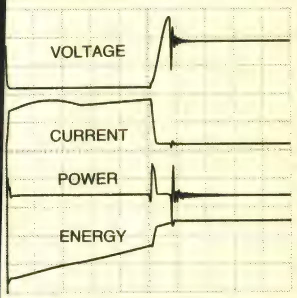

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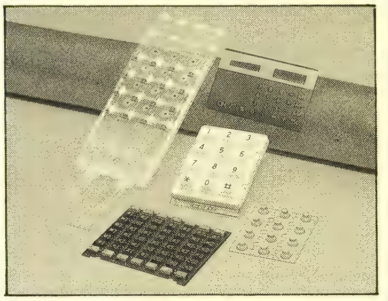

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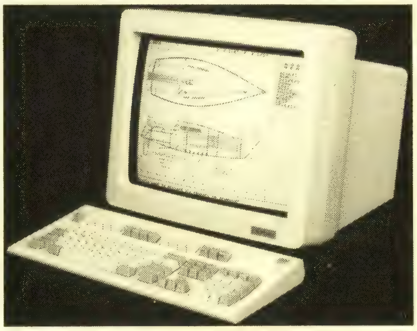

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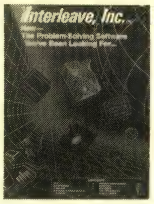

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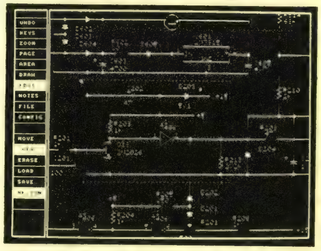

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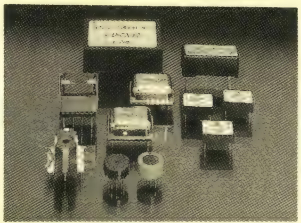

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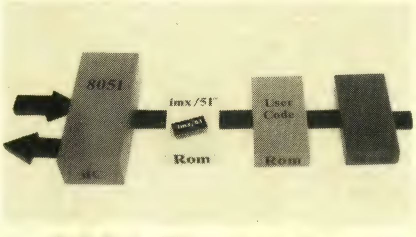

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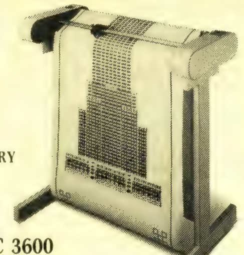

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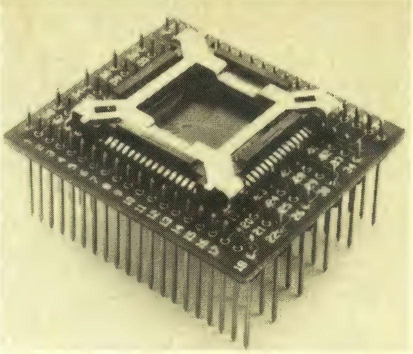

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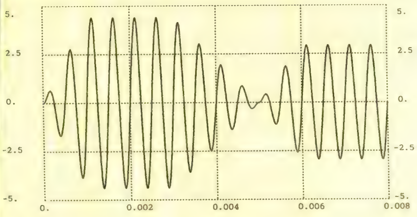

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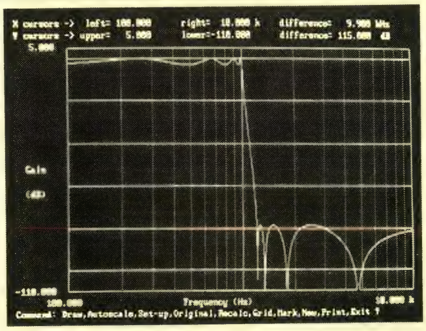

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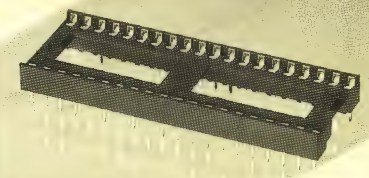

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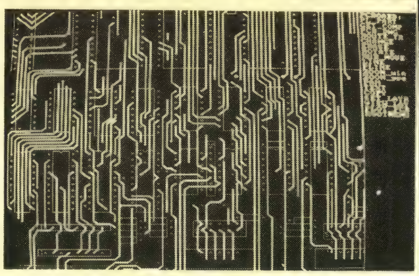

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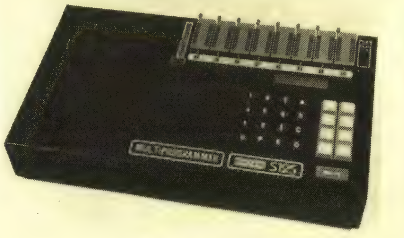

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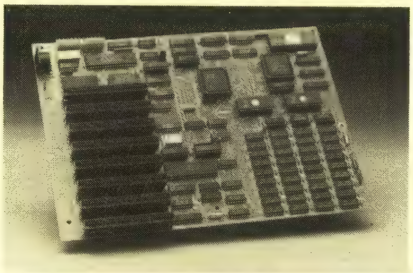

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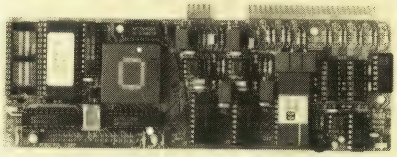

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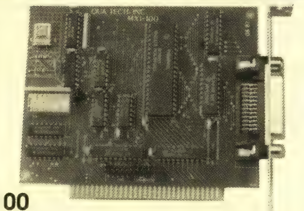

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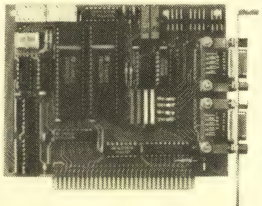

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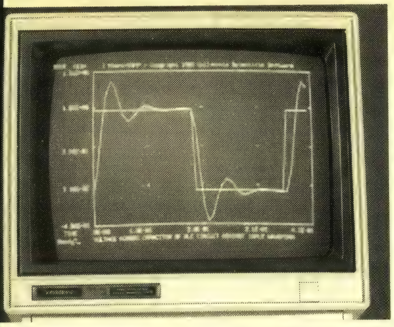

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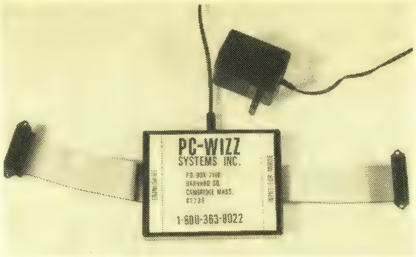

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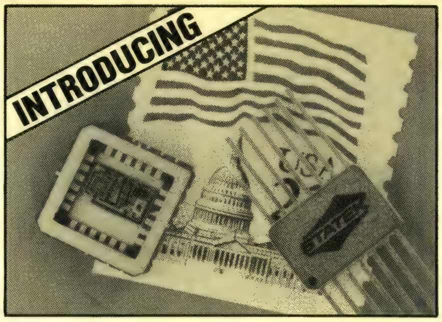

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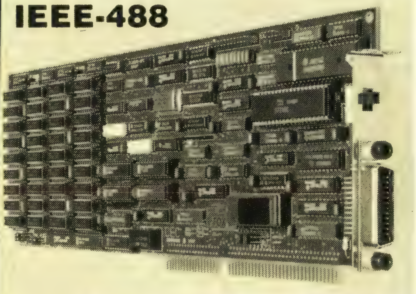

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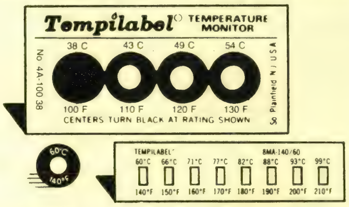

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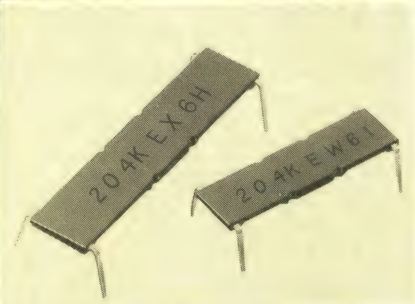

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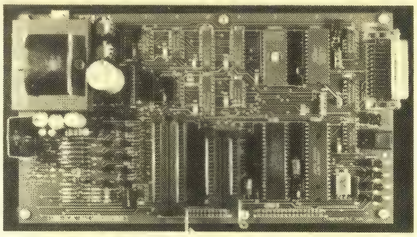

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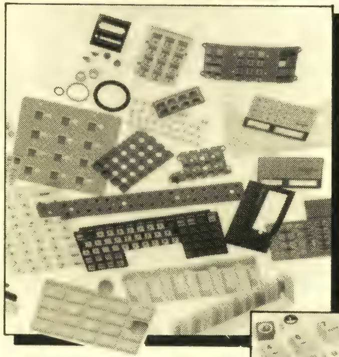

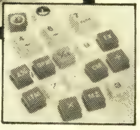

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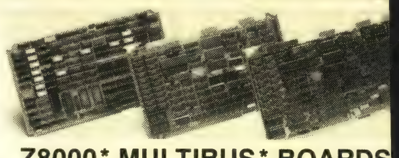

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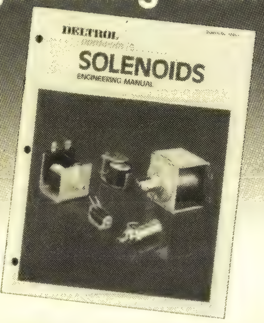

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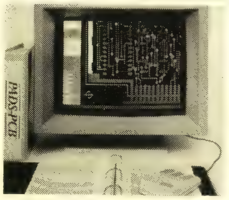

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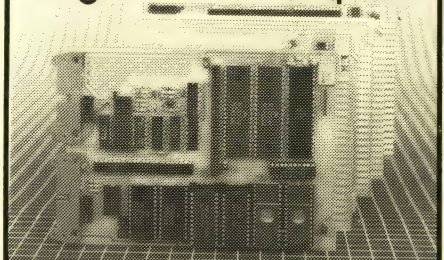

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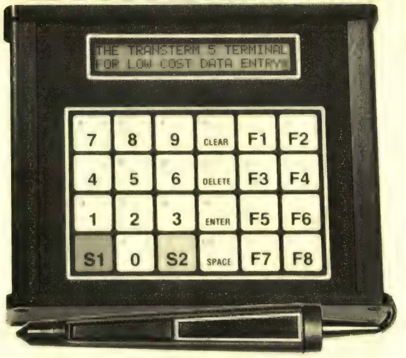

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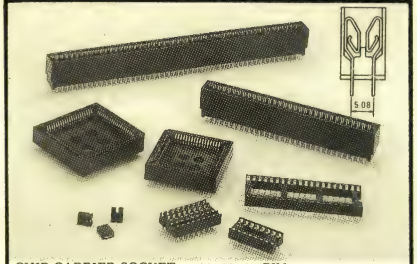

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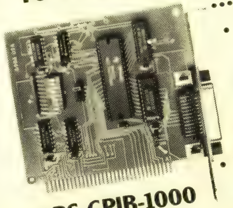

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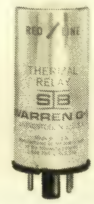

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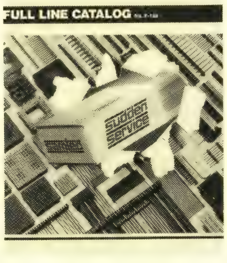

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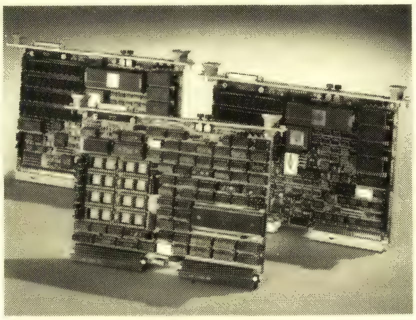

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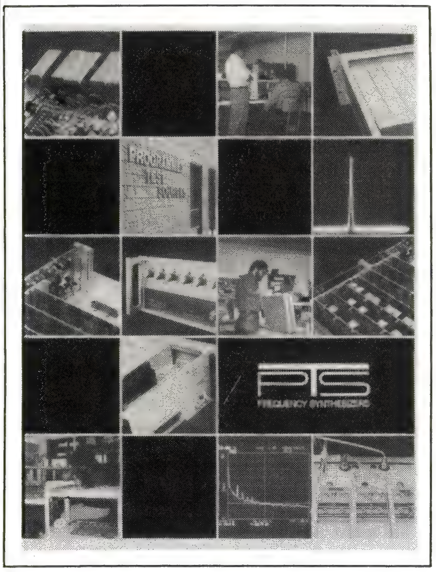

Frequency synthesizers described

This 20-pg, 4-color catalog provides general information about frequency synthesizers and outlines their characteristics. It lists specifications for the product line and provides illustrations of each device. The back of the catalog includes ordering information; data sheets for the company's newest models are also included.

Programmed Test Sources Inc, Box 517, Littleton, MA 01460.
Circle No 443

Reference offers solutions for measurement and control

The first edition of *Applications Notebook: The Total Solution for Measurement & Control* is an 86-pg reference publication that's divided into four major sections. Section A provides reference tables with a Fahrenheit to Celsius temperature-conversion chart and mathematical and physical constants and formulas. Section B presents 1-pg application solutions to problems in temperature, flow, resistance, fluid level, and other process measurements; a system block diagram accompanies each application. Section C includes the company's services and guidelines for modifying products and explains the in-house R&D custom-modifications group. Finally, Section D lists the company's support services, and includes an ordering guide.

Action Instruments, 8601 Aero Dr, San Diego, CA 92123.
Circle No 444

Complete listing of semiconductor ATE

The *Advantest Semiconductor ATE System Selection Guide* summarizes the company's entire line of semiconductor automatic test equipment. It shows the compatibility of the company's test systems, as well as the wide range of systems that are available for testing VLSI, analog, memory, and mixed-signal semiconductor devices. Individual charts for each device's testing category allow you to make cross-refer-

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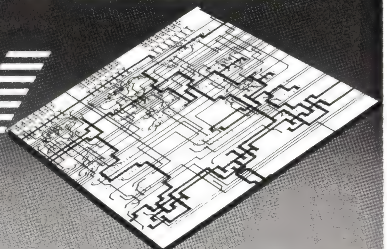

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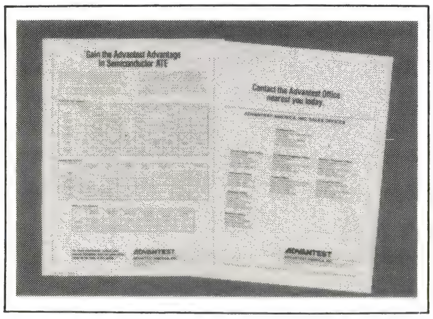

ences to system test rates and model numbers.

Advantest America Inc, 300 Knightsbridge Parkway, Lincolnshire, IL 60069.

Circle No 445

Pamphlet on transceivers

The 6-pg brochure features MIL-STD-1553 single-channel transceivers in ±12, 5, ±15, and 5V versions. It discusses low-power dissipation, receiver-output logic options for encoder/decoder compatibility, third-order balanced-receiver input filtering, short-circuit protection of transmitter outputs, and a programmable transmitter thermal-shutdown option. Detailed specifications, schematics, outline drawings, and ordering instructions complete the write-up.

Stantel Components Inc, 636 Remington Rd, Schaumburg, IL 60173.

Circle No 446

Brochure highlights electronic products

This 4-color brochure (Publication No 5953-7040) presents information on 22 basic electronic measuring instruments that are grouped into four types: digital multimeters; counters; pulse and function generators; and power supplies. Included in the leaflet are brief product descriptions, specifications, and prices. A free HP-28C calculator is available with an order of any three of the basic instruments by December 15, 1987.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303.

Circle No 447

Surface-mount versions of discrete devices discussed

This literature kit describes the company's discrete devices that are available in the DPAK surface-mount package. It combines all the technical literature on the DPAK products into one package. The kit includes the DPAK Update; the Surface Mount Selector Guide; a reprint of *DPAK, The Power Package For Surface Mount*; a tape-and-reel data sheet for surface-mount devices; and DPAK product data sheets.

Motorola Inc, Literature Distribution Center, Box 20924, Phoenix, AZ 85063.

Circle No 448

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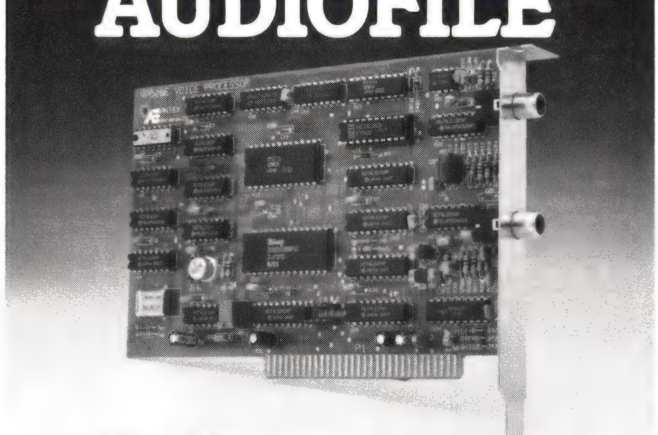

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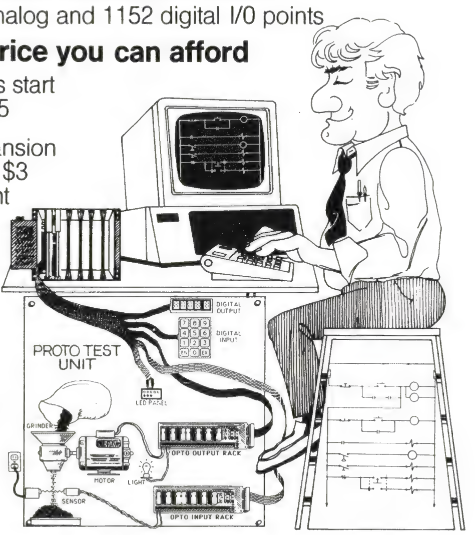

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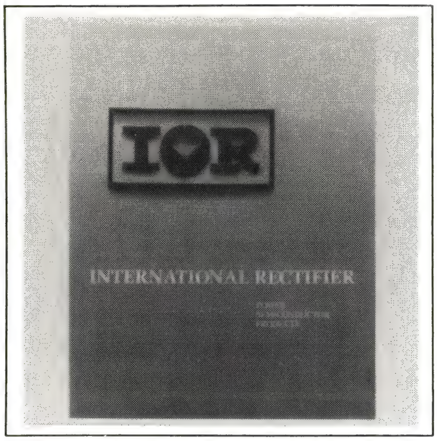

Catalog of power semiconductors

The 144-pg *Power Semiconductor Catalog* covers the company's range of products. It provides tables with key specifications for each product type, accompanied by drawings and dimensions for each package. The products covered include HexFET power MOSFETs; Schottky rectifiers; ultrafast recovery diodes; standard- and fast-recovery rectifiers; phase-control, inverter-type, and gate turn-off thyristors; power modules; military/government and custom products; and custom/standard assemblies, such as heat sinks and mounting hardware. Other sections include available literature, product cross-references, a JEDEC/alphanumeric index, and descriptions of quality/reliability programs.

International Rectifier, 233 Kansas St, El Segundo, CA 90245.

Circle No 449

Guide to software and services

The Directory of Micro Engineering Software/Services provides detailed information about engineering software and associated services. The book, divided into 27 sections, contains more than 700 micro-engineering packages and furnishes more than 250 company descriptions. The packages are grouped into sections by their engineering function, such as civil engineering, CAD, mechanical engineering, or structural/stress analysis. The book provides you with system requirements, pricing, and maintenance/support information. The company descriptions include market emphasis, types of services provided, sales volume, geographical area serviced, and principal contacts. The directory also includes a product index, which lists packages in alphabetical order; a vendor index that helps you determine which packages and services a vendor offers; and a service index that cross-refers the service vendors according to the type of service offered and the market area serviced. $239.

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Listing of test and measurement instruments

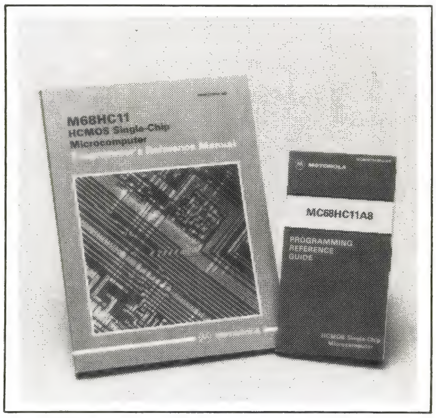
This 64-pg catalog presents more than 1400 products from A W Sperry, Amprobe, B&K Precision, Check-It, Fluke, Simpson, TIF, and Yokogawa. Among the products listed are leak detectors, counters, generators, oscilloscopes, a variety of meters, and power supplies. The products described fill the requirements of HVAC (heating, ventilation, and air conditioning), refrigeration, automotive, electronic, electrical, and industrial users.

W W Grainger Inc, 1250 Busch Parkway, Buffalo Grove, IL 60015.

Circle No 451

Reference set details HCMOS programming

The M68HC11PM/AD, a Programming Reference Manual, is the basic software reference document for the MC68HC11 family of high-speed, CMOS single-chip μC devices. Besides general information, it presents descriptions of CPU register and addressing modes, instruction-set details, cycle-by-cycle CPU bus activity, and miscellaneous conversion tables. The MC68HC11-A8RG/AD, a pocket programming reference guide, includes sections on programming models, crystal-dependent timing, interrupts, memory and opcode maps, addressing modes, execution times, Hex/DEC conversions, and an ASCII chart.



Motorola Inc, Microprocessor Products Group, 6501 William Cannon Dr W, Austin, TX 78735.

Circle No 452

Document explains software system

This 4-pg, 4-color brochure presents an overview of the company's Opera

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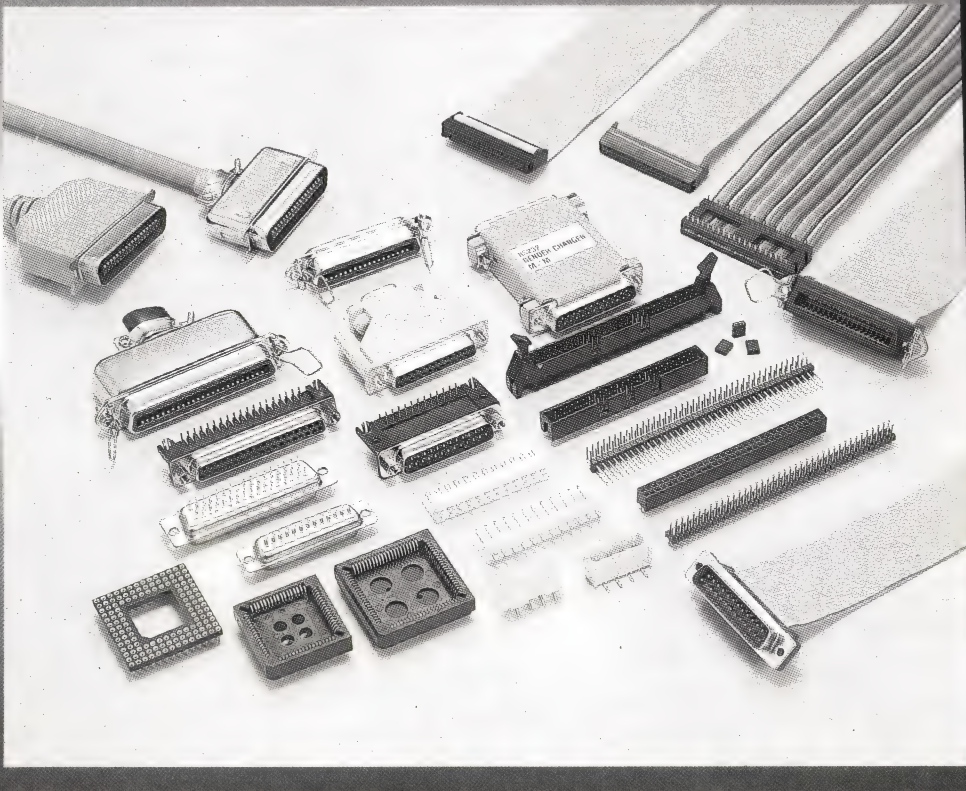


software system, a project-management risk-analysis program for the IBM PC, PC/XT, PC/AT, and compatibles. The publication sums up the package features, lists the hardware/software requirements, and contains drawings of sample screens.

Welcom Software Technology, 1325 S Diary Ashford, Suite 125, Houston, TX 77077.

Circle No 453

Literature package has app notes, product guide

This package of publications comprises four application notes, a VAXBI Third-Party Directory, and a product guide entitled, *New Opportunities*. The notes explain how the vendors products interact with other companies' products to make manufacturing tasks easier. The directory lists tool and service vendors and licensed option vendors. Finally, the guide describes the company's microcomputer systems, local-area networks, and local-area VAX-cluster systems.

Digital Equipment Corp, Channels Marketing Group, 2 Mount Royal Ave, Marlborough, MA 01752.

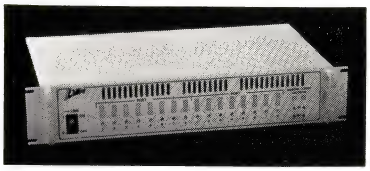
Circle No 454

Networking system described in brochure

This CADDSnetwork pamphlet presents the networking capabilities of the CADDStation family of CAE/CAD/CAM workstations. It describes the data highway that allows access to computers from IBM and Digital Equipment Corp, as well as from the company. At the CADDStation level, networking is enhanced by windowing, which allows simultaneous access to Unix, IBM's VM, Digital Equipment's VMS, and the design data base.

Computervision, Dept 615, 100 Crosby Dr, Bedford, MA 01730.

Circle No 455



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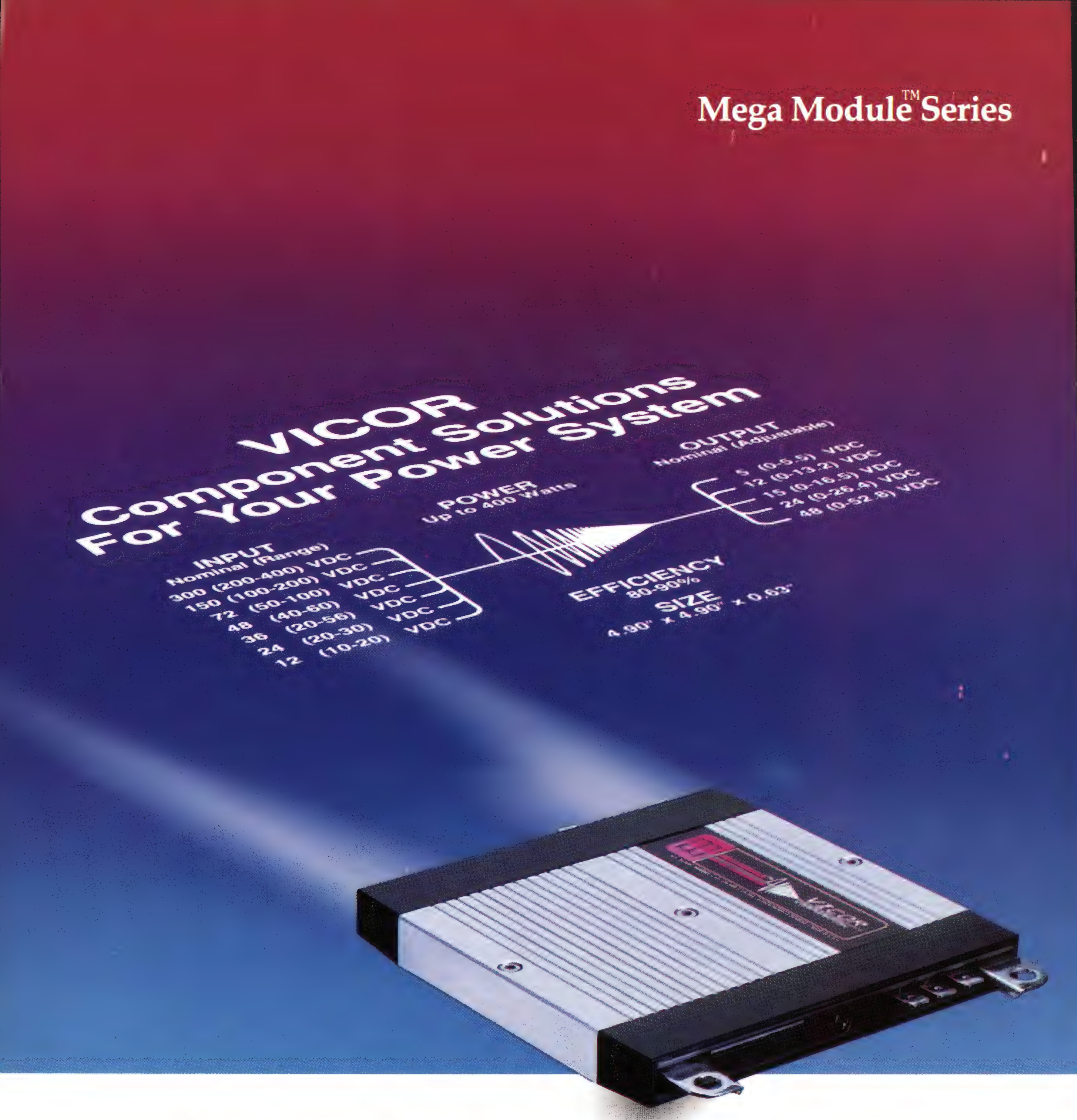

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CIRCLE NO 233

Attending graduate school via videotape

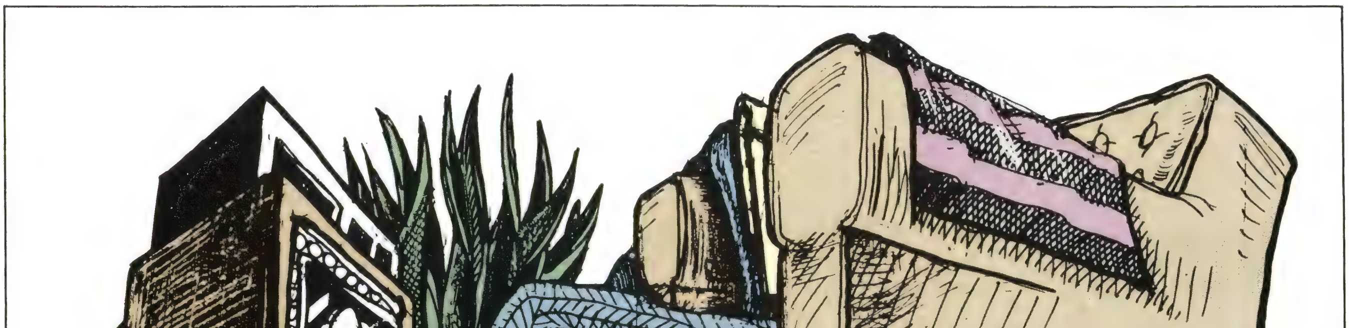
Deborah Asbrand, *Associate Editor*

National Technological University pushed video education a step forward in 1983 when it assembled the best video courses from 19 universities, packaged them into advanced-degree engineering curricula, and began beaming them via satellite to corporate work places. Video education was nothing new, but NTU's plan was: It would offer technical professionals a way to study and earn graduate degrees at some of the nation's most prestigious universities without ever having to leave the work place.

Now, four years later, NTU is producing its first graduates. Eight students have been graduated, and more will follow as the school's enrollment climbs. This academic year, NTU expects 2000 students to register for courses. In August, NTU was accredited by the North Central Association of Colleges and Schools.

With an average of nine to 11 NTU classes to their credit, graduates are well versed in the intricacies of study via videotape. NTU alumni say the school's compilation of courses from nearly two dozen universities lets students customize their educations. They also report that the option of watching classes on videotape allows them to adjust their "in-class" time to their schedules. But video teaching still has some bugs in it, including classrooms ill-suited to filming, camera-shy instructors who mumble or write on the board in letters too small to read, and slow distribution of course handouts and homework.

Ram Sudama was graduated from NTU in June, when he received a master's degree in computer science with a concentration in artificial intelligence. Sudama, a consultant en-



Denise St Germain

gineer for Digital Equipment Corp's Littleton, MA, distributed systems architecture and advanced development facility, considered graduate study for some time before finally taking the plunge, investigating local schools such as Boston University, the Massachusetts Institute of Technology, and the University of Massachusetts at Amherst.

To pass the time while he decided where to apply, Sudama enrolled in an NTU course in advanced data structures that was taught at the University of Minnesota. The course's content impressed him, and he decided to pursue a degree via NTU. "The selection of courses was much broader than at the other schools I was thinking of attending," he says. "In artificial intelligence, for example, they have 15 to 20 course offerings. Most universities . . . have two or three." Sudama took courses from the University of South Carolina, Colorado State University, Southern Methodist University, the University of Massachusetts, and Northeastern University.

Flexible class attendance

Along with the videotapes, NTU students also watch live broadcasts of classes. Sudama says that his schedule allowed him to watch only about one-third of the classes at the time of their broadcast. The remainder he watched on tape at his office or at home.

The convenience of obtaining VHS tapes of the classes and watching them as their schedule permits is important to NTU students. The proliferation of home videocassette recorders means more students can "attend class" at their leisure. For busy professionals, this is a key consideration. Sudama says that he was able to travel as planned and then watch tapes of the classes he'd missed while away.

The proliferation of videocassette recorders means more students can "attend class" in the comfort of their own homes.

Although NTU administrators prefer that students watch classes in the work place with other students, the significance of the videocassette option is not lost on them: They understand that work and family responsibilities often make it difficult for adults to attend classes presented at a particular time. "I don't think you could have a satellite network without VCRs," says NTU president Lionel Baldwin. "You're dealing with busy adults and their chance of being able to attend every class is nil."

For individuals employed in rural areas, such commute-less classes are ideal. Michael Reiss works as a consultant analyst for NCR's Retail Systems Division in Cambridge, OH. Cambridge, with a population of 13,500, is tucked in the southeastern corner of the state. The two nearest universities—Ohio State University in Columbus and the University of Akron—are more than 75 miles away. A videotaped curriculum was perfect for him.

Reiss watched all of his first course at his work site. But by the time he enrolled in his second course, he'd purchased a videocassette recorder and so began watching the tapes at home. Viewing the classes in his living room made studying more convenient, and thereafter he took two courses per semester. In November 1986, he became the first student to earn a master's degree via satellite courses. He donned a cap and gown for the ceremonies, which were attended by NTU dignitaries and broadcast from his work site over the school's satellite network.

"If you're taking a normal course load in a graduate program, you're expected to be on campus when the class meets and to take advantage of the lab hours when they're available," says Reiss, who earned a degree in computer engineering. "The best thing about [NTU's] program is that you're not tied to a schedule."

Videotaped classes also let a student study at his or her own pace. "If I didn't understand something that was said," remarks Sudama, "I could back it up and listen again. If I knew the material being covered, I could fast forward the tape."

The freedom that comes with attending classes at one's own convenience can cause trouble for some students. "The danger is it's really easy to let those tapes pile up," says Paul Melnychuck, a research scientist for Eastman Kodak in Rochester, NY. "I sometimes had to spend a whole Saturday catching up." Melnychuck, who graduated last June with an MSEE, won't reveal the number of classes by which he fell behind, but says that "the stack of tapes could have made a nice plant stand."

Other students had less trouble. Sudama says that as an undergraduate student at Johns Hopkins University, he frequently cut classes. As an NTU student, though, he was never even tempted to play hooky. "I don't know if it's because I'm older, but I never missed a class."

The solo style of learning only occasionally distracted the students. Most felt that they traded companionship for convenience. "You tend to be a loner when you're a video student," says Melnychuck. Most graduates say that they consulted with colleagues about problems, or telephoned the teacher during prescribed telephone office hours. Instructors proved accommodating to off-campus students, NTU students report.

Although he watched many of the classes at home, Sudama says it was important to him to know that there were others studying the material at the same time as he, something he had missed when enrolled in other video classes.

Instructor adaptation to the camera, however, was inconsistent. Some of the professors were consummate video lecturers and enhanced their classes with the use of transparencies and other video teaching tools. But other problems cropped up. "A few of the schools had lighting problems, or a professor wrote on the blackboard and then wound up blocking it," says Melnychuck, who withdrew from one class because of poor audio and video conditions. Sudama reports that occasionally professors made pertinent remarks after class and thus put the video students at a disadvantage.

New challenges for teachers

For their part, instructors admit that teaching off-camera students presents a challenge. Their lectures must be timed to end as scheduled; it's not possible to hold the class late if the professor hadn't covered all of the material he'd planned. Class materials and exams have to be prepared in advance to allow time for their mailing to off-camera students. Teaching on camera "is twice the amount of work," says Ronald Bonnell, a University of South Carolina professor who has taught video classes since 1970. "You have to be very organized. Most instructors won't wing it in a TV class. They're being taped for posterity, so they come prepared."

Interested in experiencing a video class from the students' end, Bonnell enrolled in one. "I wanted to see what it was like," he says. "I took 27 hours of class to get a feel for what students were going through. I actually liked it much better than I thought I would. I liked the idea that if I had 45 minutes free, I could sit down and watch it." Bonnell's research is evident in his teaching methods, says Sudama, who rated the instructor's course in expert systems as one of the best that he took.

Some professors, though, enter class unprepared to meet their off-camera students' needs, which has led various schools to train their faculty to use the camera to their best advantage. "We discovered they needed to know more about the new environment in which they were operating," remarks Dan Harrell, director of engineering extension at North Carolina State University. "We wanted the professors in our courses to look as professional as [possible]."

The solo style of learning only occasionally distracted the students. Most felt that they traded companionship for convenience.

After watching the filmed classes, the college made some changes in its procedures, says Harrell. For starters, it replaced the traditional blackboard with a white board. "It didn't make sense to use the blackboards," he says. "If you're always talking to the blackboard, the audio isn't good. And once you go through one erasure, the board becomes very cloudy looking." The school also installed special lighting, a microphone, an overhead camera that focuses on a desktop writing pad, and a light pen with which instructors can highlight slides.

Roll the cameras

The University of Maryland sets aside one evening at the beginning of each school year to introduce new faculty members to the equipment in its four video classrooms. The school annually broadcasts more than 100 courses, mostly in electrical engineering and computer science, and the classrooms are used more than 60 hours each week. "The biggest barrier we face in training these people is that they are terrified," says Susan Kromholz, assistant director of the university's instructional-TV system. "They don't like the way they look, and they're afraid their bald spot is going to show." Engineering professors, used to writing long equations that span an entire blackboard, must adapt their presentations. "And that takes work," says Kromholz.

Such work results in much better classes. Students say it's obvious which schools take the time to train instructors in video presentations. The quality of each professor's on-camera teaching skills is up to him and to his university; NTU's role is to facilitate the broadcast of the courses. But NTU polls its students on classroom conditions within the first two weeks of each semester so that it can take action should a course get off to a rocky start.

When polling began in the fall of 1986, 16% of the students rated course video and audio quality as unsatisfactory. Seventeen percent complained that they had not yet received the syllabus, and 40% reported that they were not receiving class handouts in a timely manner. By last spring, students' ratings of the classes had improved. Although 17% of the students still rated the picture quality as unsatisfactory, more deemed the audio quality satisfactory and found the turnaround time on mailed class materials acceptable.

In many ways, NTU students are more committed to academics than are their counterparts at traditional institutions of higher learning. They enjoy none of the amenities of the conventional student: NTU has no student organizations or activities, no library or cafeteria, no campus bookstore. Says Melnychuck: "If you want to be in a university and watch a football team on Saturdays, that's not NTU." **EDN**

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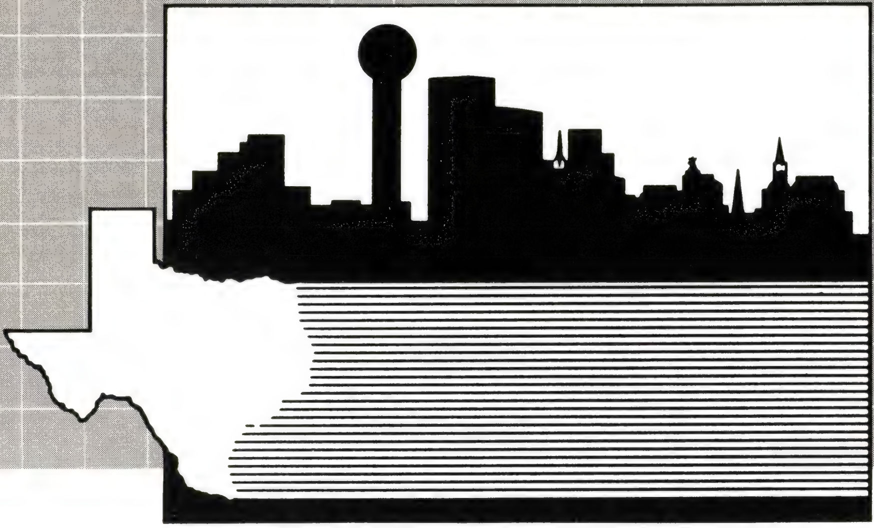

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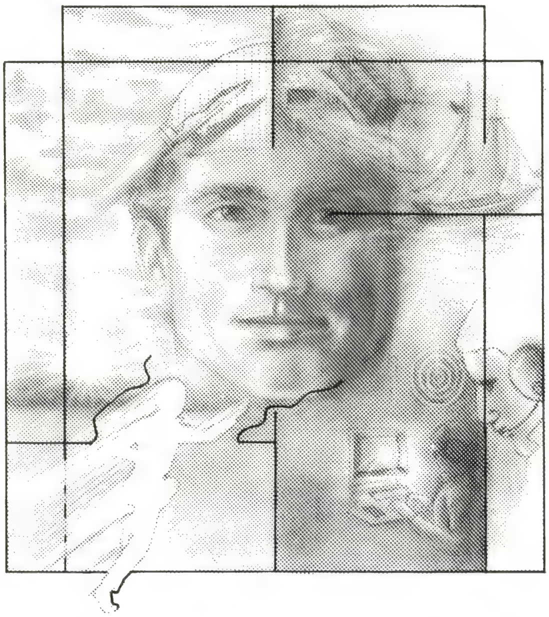

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Responsible for VLSI detail logic circuit analysis and debug of Bipolar oxide isolated products, CMOS and BICMOS. A BSEE and 2 or more years of semiconductor design and product engineering experience is required.

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Direct photo engineering activity and provide process development leadership. Extensive experience with wafer steppers, positive photo resist, 2M geometries, sustaining photo production operations and evaluating and selecting new photo equipment. A BS degree is required, MS preferred.

DA/CAD R&D SECTION MANAGER

Minimum MSEE/CS or MSCE and 6 years experience. Specialized in the areas of hierarchical/performance-driven placement routing system for gate array design. Knowledge in computer-aided test engineering, simulators and silicon compilation.

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Minimum MSEE/CS or MSCE and 4 years experience. Work experience as floor planner, routing algorithms and familiar with various languages such as C, C++, Pascal, VHDL, etc.

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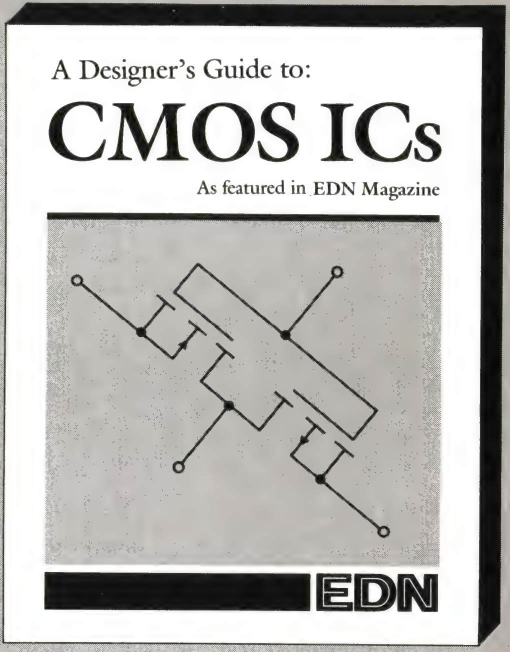

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**TURN TO
PAGE 354**

LOOKING AHEAD

EDITED BY CYNTHIA B RETTIG

US PACKET-SWITCHING SERVICE REVENUE BY APPLICATION
($ MILLION)

	1987	1989	1991
TIMESHARING	$197	$205	$200
DATABASE ACCESS	150	300	455
SEMIPRIVATE ACCESS	180	297	400
ELECTRONIC MAIL	57	96	158
POS	9	30	90
EDI	7	30	94
INTERNATIONAL	50	110	185
LOCAL	NEGLIGIBLE	10	30
TOTAL	$650	$1078	$1612

(SOURCE: INTERNATIONAL RESOURCE DEVELOPMENT INC)

Short boom in store for packet-switching industry

The packet-switching services and systems market might experience substantial, imminent growth, predicts International Resource Development Inc (IRD). As a result of changes in US data communications, revenues for packet-switching enterprises could reach $1078 million by the end of 1989. However, the New Canaan, CT, market-research firm warns vendors that the market will peak by 1991 and thereafter face strong competition from new products, technologies, and price developments. By the end of the century, packet-switching commerce should recede to a lower but stable plateau, supported by military and specialized applications.

Packet-switching systems and services have just recently begun to enjoy sanction by IBM for use with its teleprocessing equipment here and in Canada, a development that allows packet networks to interface with a much greater array of products. The introduction of IBM's Systems Application Architecture (SAA) and its related products has given Systems Network Architecture (SNA) users a choice, IRD points out. SAA software permits mixed interconnection of products and thus provides a wider selection of lower-cost transmission techniques, including public packet-transmission services and private packet networks. Other actions by and new products from major telecommunications-equipment manufacturers have also simplified the operations of mixed-media data-communications networks.

Two developments will constitute the major threats to packet switching's market position within the next few years. Because of recent dramatic advances in fiber-optic technology, fiber-optic networks should proliferate, seriously challenging the price structures of basic long-distance transmission services by 1991. Furthermore, the movement of public telecommunications networks toward ISDNs (Integrated Services Digital Networks) seems to be threatening the cost advantages of packet switching. Although the effects of this trend on packet markets will depend on the tariffs for different services based on ISDNs, marked changes should occur in both European and US markets by 1992.

Despite the bleak, long-term prediction that packet switching will retain only niche markets by the year 2000, important commercial opportunities remain for short- and medium-term market strategies. The growth of on-line databases offering efficient and simple access to financial, business, and legal facts will be the driving force behind the general market, which could reach $1.6 billion by 1991. Consolidation and mergers seem both inevitable and expedient in the industry, which IRD characterizes as possessing clearly defined market possibilities and a disproportionate number of players.

"Interoperability" is watchword in data sharing

Advancements in the ways that different computers and their peripherals exchange data have caused interchange techniques to undergo various phases and to assume complicated names suited to their more difficult tasks. According to the Diebold Group (New York, NY), which has researched these trends in order to forecast further developments, *interoperability* presents the current challenge. The compatibility and portability sought in the 60s and 70s gave way to a quest for interconnectibility in the early 80s. During those years, the subjects of interchange were character streams and untranslated data structures, and the demand was for bidirectional exchange between dissimilar and networked computer systems.

The late-80s challenge of interoperability involves the multidirectional interchange of data structures, structured text, and encoded images among two or more dissimilar, networked computers. The achievement of interoperability is made difficult by the different hardware and software products offered by vendors, by inconsistent standards, and quite simply, by inconsistent data-access and -modification rules. Diebold's conclusions highlight the need for, among other things, information directories that convey integrity contraints, network directories that automate network-resources management, object-based designs that simplify access procedures, and consistent operating environments for software packages.

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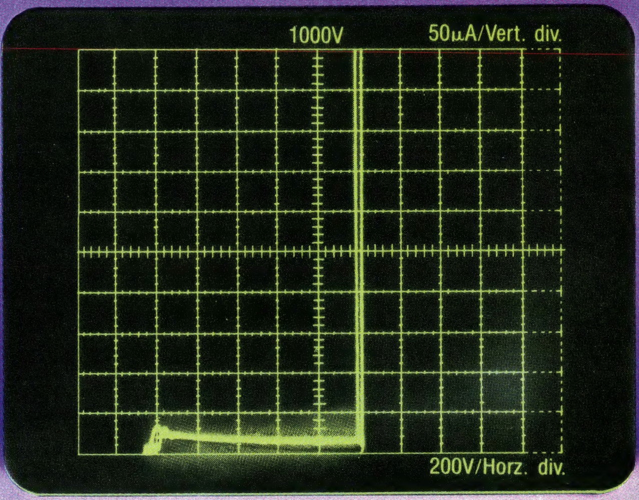

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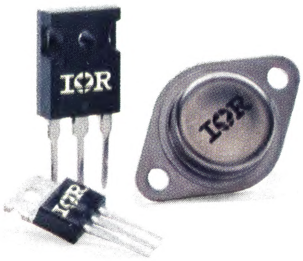

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